Water Resources

HISTORY OF FLOODS IN THE OLDMAN RIVER BASIN

Alberta
ENVIRONMENT

History Of Floods In The Oldman River Basin

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Alberta
ENVIRONMENT

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JUNE, 1985

FOREWORD

The objective of this report is to present historical information and data concerning the floods in the Oldman River Basin and the South Saskatchewan River at Medicine Hat. It is the intent to provide in one report, the most significant flood data and information which may be available in any of the several existing publications.

There are currently about fifty-five active hydrometric stations in the Oldman River Basin. This report presents data for twenty-one selected hydrometric stations. Streamflow data have been collected for the Oldman River for approximately seventy years and there are several publications which give the recorded flood data in various forms.

The report preparation, the compilation of data, and the analyses were done by the staff of the Technical Services Division, Water Resources Management Services, Alberta Environment.

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ACKNOWLEDGEMENTS

Thanks are expressed to the following agencies for providing information:

Water Survey of Canada, Environment Canada
Atmospheric Environment Service, Environment Canada

Photographs were supplied courtesy of the following:

Water Survey of Canada, Environment Canada
Prairie Farm Rehabilitation Administration (P.F.R.A.)
Calgary Herald
Alberta Recreation and Parks, Southern Region
The Archives, Sir Alexander Galt Museum, City of Lethbridge
N.E. Kloppenborg, Canada Agriculture, Research Station, Lethbridge
Lethbridge Herald
Del Steed, Cardston
Dick Allison, Lethbridge

Sections of this report were written by D. R. Graham, S. Figliuzzi, and H. Rickert. These are acknowledged in the respective sections of the report.

The report was typed by Sharon Ross, Hydrology Branch, Alberta Environment.

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ABSTRACT

This report presents some of the most significant historical flood information and data for twenty-one selected hydrometric stations in the Oldman River Basin and the South Saskatchewan River at Medicine Hat. The principal sections of the report cover maximum annual flood discharge data, causes of floods, the effect of ice on recorded stages, historical flood levels, flood damages, and flood frequency analyses.

Tables and histograms of the maximum annual floods, discharge hydrographs, selected river stage data, and flood frequency curves are presented for the twenty-one selected hydrometric stations.

The report also lists other flood related information and data which are currently available from the Technical Services Division, Water Resources Management Services, Alberta Environment.

INTRODUCTION

Objective

The objective of this report is to present information and data concerning recorded floods in the Oldman River Basin and the South Saskatchewan River at Medicine Hat (Figure 1). It is intended to provide a compilation of historical flood data and information which may already be published in several other reports or data books. This report also includes flood frequency analyses and inferences as to the causes of the floods.

In this report, the word "flood" does not necessarily mean that there was inundation related to the event. It might simply refer to the peak river stage or peak flow in a particular year.

Selection of Hydrometric Stations for the Report

Although there were approximately fifty-five hydrometric stations in operation in the Oldman River Basin in 1982, the data presented in this report are for twenty-one selected stations. Figure 2 is a listing of the selected stations along with other pertinent data concerning each station.

The stations were selected to give a good representation of floods in the mountain, foothills, and plains regions, as well as along the mainstem of the Oldman River. The number of years of hydrometric record was also an important criterion in station selection. Although the station on the Oldman River near Fort MacLeod has been discontinued since 1948, it has been included in this report because it has over thirty-eight years of streamflow records.

This report presents data recorded up to the end of 1982. Figure 2 gives complete details on the period of record and the type of operation for each of the selected stations.

Terminology and Units

Terms used frequently in the report are defined below.

Flood - peak river stage, gauge height, or the peak flow, in a particular year.

Hydrometric station or gauging station - a location where records of river stage and discharge are obtained.

Maximum annual flood discharge - the highest daily discharge occurring in any given year.

Maximum instantaneous discharge - the highest momentary discharge in a specified period. In the case of manual stations where only one or a few observations were made during a single day, it usually signifies the highest discharge that could be inferred from the observations reported or from high water marks, which may then be qualified as "estimated", therefore, maximum instantaneous discharges for manual stations are subject to some degree of uncertainty.

Maximum daily discharge - the highest daily discharge in a specified period. Where the period is a single water year, it is referred to as maximum annual daily discharge.

Mean daily discharge - the average discharge over a single calendar day.

River stage or gauge height - the height of the water surface at a station above an arbitrary elevation known as "gauge zero".

Gauge zero - an arbitrary datum above which the elevation or height of the river stage or gauge height is measured. Gauge zero does not necessarily correspond to minimum water level, zero discharge, or any other consistent flow condition. (At some stations the elevation of gauge zero has been changed from time to time.)

Gauge datum - has the same meaning as gauge zero as stated above.

Systematic records - annual peak discharge information collected in a systematic manner by means of an observer, a stage recorder, or a crest-stage gauge.

Regulated discharge - the actual (recorded) discharge measured at a station affected by river regulation works, diversion, etc.

Natural discharge - the discharge at a station that would have occurred without regulation upstream of the station.

Historical flood - a flood event at a station since records have been kept.

Historic flood - a flood which occurred either before or after the period of data collection and whose peak discharge has been either recorded or estimated.

Cubic metre per second (m^3/s) - a unit expressing the rate of discharge. One cubic metre per second is equal to one cubic metre of water flowing past a particular point in one second.

The following units are used in this report:

Discharge - cubic metres per second (m^3/s) or cubic feet per second (cfs)

Gauge height - metres (m) or feet (ft).

UNIT CONVERSION FACTORS

1 inch	=	25.4	mm.	1 mm.	=	0.03937	in.
1 ft.	=	0.3048	m.	1 m.	=	3.2808	ft.
1 mile	=	1.6093	km.	1 km.	=	0.62137	mi.
1 $ft.^2$	=	0.0929	$m.^2$	1 $m.^2$	=	10.764	$ft.^2$
1 $mi.^2$	=	2.59	$km.^2$	1 $km.^2$	=	0.3861	$mi.^2$
1 $ft.^3$	=	0.02832	$m.^3$	1 $m.^3$	=	35.315	$ft.^3$
1$ft.^3$/sec	=	0.02832	$m.^3$/sec	1 $m.^3$/sec	=	35.315	$ft.^3$/sec

1 ac.ft. = 43,560 $ft.^3$ = 1,233.5 $m.^3$
1 ac.ft./mi^2 = 0.01875 in. = 0.47625 mm.

BASIN DESCRIPTION

The Oldman River, which is a tributary of the South Saskatchewan River system, has a drainage area of approximately 27,500 square kilometres in south-western Alberta and northern Montana. Detailed descriptions of the basin have been included in reports by Collier (1965), Warner (1973), Janz (1976), Saskatchewan Nelson Basin Board (1972), and Phinney (1982).

The following regional descriptions are taken, with a few minor changes, from the report by Warner (1973).

The Oldman River drainage basin may be divided into three general regions which are significantly different in geology, topography, climate, and vegetative cover and which therefore have a markedly different effect on the regime of the streams in the basin. These three regions may be termed the mountains, foothills, and plains regions.

Mountain Region

The headwaters of the main tributaries lie in the mountain region, which extends northward from Glacier Park in Montana in a widening belt between the Continental Divide to the west, and the foothills in the east. This region is less than 15 kilometres wide at the International Boundary and expands steadily to the north of the watershed, reaching a width of approximately 90 kilometres at the northern limits of the watershed. The mountains rise abruptly from the foothills, particularly to the south where the break of slope is conspicuous against an embayment, often termed the rolling plains.

Local relief in the mountains is extreme, the larger stream valleys lying between 1280 and 1520 metres in elevation and the surrounding peaks reaching elevations of 2440 to 3200 metres. The major streams emerge from the mountains and enter the foothills region at about 1280 metres in elevation. Mountain ranges have a general north-to-south trend.

The timber line lies approximately at the 2130 metre level. Most of the region below that elevation is covered with a heavy forest where spruce and pine predominate. Infiltration, evapotranspiration, and runoff characteristics below the timber line are typical of areas with heavy forest mantles. Above the timber line, where the heaviest snow accumulations occur, runoff is primarily the result of snowmelt and is largely confined to the months of June through September. A pronounced diurnal fluctuation in runoff is characteristic at this elevation.

Foothills Region

The foothills region is the belt lying parallel to and immediately east of the mountain region. Its eastern boundary is not well defined because of the dissected nature of the ridges and the masking of the underlying strata by glacial deposits, but it is roughly delineated by the 910 metre contour. Local relief in the foothills may exceed 300 metres in places with the whole region tending to lie between the 910 metre and 1830 metre contours. Vegetative cover varies from forest to rolling grassland.

The larger streams cross the foothills from west to east, the longitudinal valleys between the ridges being occupied by small tributaries. The principal streams enter the region from the mountains at an elevation of approximately 1280 metres. They may be considered as having passed into the plains region at a line through Claresholm and Fort MacLeod, at approximately 910 metres in elevation; the fall in the main streams during their passage through the foothills is approximately 370 metres and slopes may reach as much as 3.79 metres per kilometre.

Plains Region

The plains region encompasses that portion of the basin lying generally east of a line through Claresholm and Fort MacLeod. Most of this region appears to have reached the peneplain stage prior to the last ice age. Such irregularities that remained were afterwards masked by glacial deposits so that the landscape tends to be created more by land use than by changes in relief.

In the plains region, the variability of the deposits ranging from coarse gravel to fine clay, and the lack of pronounced slopes, produce an unorganized drainage pattern over large parcels of the country. There are, within the broader boundaries of the major basin, many undrained potholes, marshy areas, and small basins with interior drainage. Old drainage channels created during the retreat of the ice sheet interrupt the surface which otherwise appears flat and monotonous.

The few tributaries, rising in the plains region, make only very minor contributions to the total discharge in the main streams, and the water, that is gathered in the mountains and foothills, passes across the plains in a quantity out of all proportion to the local yield. More than 85 percent of the annual discharge is derived from the drainage basin lying in the foothills and mountains of Alberta and Montana.

The major tributaries of the Oldman River basin are the St. Mary River, Belly River, Waterton River, Castle River, Crowsnest River, Willow Creek, and the upper portion of the Oldman River itself.

ANNUAL FLOOD DISCHARGE DATA

Maximum Annual Flood Discharge Data

Tables 1 to 21 give the maximum annual flood discharge data available, up to 1982, for the selected hydrometric stations. These tables were prepared from data published by the Inland Waters Directorate (1983) in Historical Streamflow Summary, Alberta, to 1982.

Where available, the maximum instantaneous discharges were given with the time and date of occurrence. The maximum instantaneous discharge is the highest, momentary discharge occurring in a given year.

Figures 3 to 13 show histograms of the annual maximum mean daily discharge for the selected stations. The histograms illustrate that the maximum annual flood peaks vary at all hydrometric stations from one year to the next, over the period of recorded data. For example, it can be seen that the flood peaks for the Crowsnest River at Frank (Station Number 05AA008), Figure 3, does not show a high variability in the flood peaks, whereas Lee Creek at Cardston (Station Number 05AE002), Figure 3, shows a high variability in the flows between the years of high flood peaks and those of low flood peaks.

Belly River near Mountain View (Station Number 05AD005), Figure 4, does not show much variability in the flood peaks, except in years of very high rainfall events, such as 1964 and 1975. In fact, the very high flood peaks on the rivers and creeks in the Oldman River Basin are caused primarily by runoff from heavy rainfall, which is sometimes augmented by runoff from snowmelt.

The South Saskatchewan River at Medicine Hat (Station Number 05AJ001), Figure 13, is also included in this report. This station shows some high flood peaks which were mainly caused by high flows from the Bow River Basin, rather than high flows from the Oldman River Basin.

Variability of Flows

Figures 14 to 21 are mean daily flow hydrographs which illustrate the variability of flows for some typical years for the selected stations. These figures are discussed in greater detail under the section "Causes of Floods".

Figure 14 shows the April 10 to July 20 daily discharge hydrographs for the Oldman River near Lethbridge (Station Number 05AD007) for several years. These hydrographs were selected to portray the variability in flows on the mainstem of the Oldman River Basin during the most active runoff period and were all plotted to the same scale for comparison purposes. It can be seen that in some years the streamflow is relatively low, such as in 1936, 1944, 1947, and 1977. The actual discharges for 1944 and 1977 are so low that the daily discharges are listed in Figure 14 for clarification purposes.

In 1975 the flows were relatively low until late June when a heavy rainfall resulted in an extremely large increase in discharge. In some years (1927, 1942, 1948) there is more than one significant flood peak, while in other years (1936, 1944, 1947, 1977) there is not even one significant flood peak.

It is important to note that almost all the major flood peaks shown in Figure 14 resulted primarily from rainfall runoff.

CAUSES OF FLOODS

Although the runoff from the mountain snowmelt generally contributes a large percentage of the annual runoff volume in the Oldman River headwaters, the extremely high flood peaks are caused primarily by heavy rainfall. The rainfall runoff may be augmented by the mountain snowmelt which may still be relatively high when the storm rainfall occurs. This generally occurs anytime in the period from late May to early July. Heavy rainfall has been associated with the major floods of 1908, 1923, 1942, 1953, 1964, and 1975. Figures 58 to 90 are photographs which show flooding at various locations.

Detailed descriptions of the meteorological conditions leading to the 1953, 1964, and 1975 floods, are given in Collier (1965), Warner (1973), and Phinney (1982), respectively.

The storms which produce the major floods in the foothills are called "cold lows". The term "cold lows" refers to a certain type of low pressure air mass which originates off the west coast of North America. The low pressure system has counter-clockwise circulation and travels generally from west to east across the continent. As the system crosses the continental divide, it often intensifies. The classic flood-producing situation occurs when the system draws warm, moist maritime air from the Gulf of Mexico and mixes it with colder air from the polar regions at the ground surface. The circulation of the air mass is such that the moisture-laden air is directed towards the foothills and mountains. The air is forced to rise, as it rises it cools, as it cools it becomes saturated, and heavy rainfall in the foothills and along the most easterly range of mountains may result. The effect of the topography on the rainfall intensity is referred to as the "orographic effect" or "upslope conditions".

Figure 15 shows discharge hydrographs for eight selected stations for the period June 1 to July 6 for 1953, 1964, and 1975. These are years of some of the highest recorded flood peaks in the Oldman River Basin, these hydrographs illustrate the high degree of areal variability which may be associated with some flood events. It

should be noted that the hydrographs for the Oldman River near Lethbridge (Station Number 05AD007) and South Saskatchewan River at Medicine Hat (Station Number 05AJ001) are plotted on different scales from the other six stations, shown in Figure 15.

By examining the hydrographs for the hydrometric stations in Figure 15 the relative contributions of the various tributaries to the flood peaks at Lethbridge and Medicine Hat can be determined. For example, in June 1953, Castle River, Willow Creek, and the Oldman River above Waldron's Corner experienced very high flood peaks while the Belly, St. Mary, and Waterton Rivers experienced very moderate peaks. This north to south decrease in flood peaks indicates that the northern portions of the Oldman River basin had heavier rainfall than the southern portions.

In the flood of 1964, the opposite was true. The larger contributions to the runoff came from the "southern" tributaries; Belly, St. Mary, Waterton, and Castle Rivers.

In the 1975 flood, there were high runoff contributions from all tributaries except Willow Creek. Figure 24 is a mass curve of rainfall for the June 1975 flood at the Waterton Red Rock site in Waterton National Park. In excess of 350 millimetres fell in a three-day period at this station.

Flood hydrographs for 1953, 1964, and 1975 are also shown in Figures 16 to 22 at a larger scale than in Figure 15.

Figure 16 shows that Willow Creek had significant runoff from the 1953 flood but recorded very little or no runoff from the floods of 1964 and 1975.

Figures 17, 18, and 21 are for the Waterton, Belly, and St. Mary Rivers, respectively. These rivers had large flood peaks for the 1964 and 1975 flood events, but contributed relatively little towards the 1953 flood peak at Lethbridge, which was the largest of the three floods at Lethbridge.

1967 Snowstorm

In late April 1967, two snowstorms one week apart produced a total of 150 to 200 centimetres of snow in south-western Alberta, Janz (1968). Most of the heavy snowfall was in the foothills and plains regions of the Oldman River Basin. No accurate estimates are available of the actual water content of the snow.

These two storms produced record-breaking snowfall for April and had serious effects on the transportation and agricultural industries. However, while the total runoff volume was relatively high, the snowmelt produced only "average" flood-peaks on the Oldman River and its tributaries, as shown in the 1967 hydrograph (Figure 14).

Urban Storms

Urban flooding can be caused by very localized rainstorms of which the intensity and subsequent runoff may exceed the design capacity of the urban storm sewer system.

It is extremely difficult to accurately predict, in advance, the severity and location of these storms because they are highly variable in movement and intensity. Similarly, because of the relatively rapid response of the urban basins to these storm events, it is, at present, virtually impossible to provide any advance flood warnings for these urban storms.

One such storm occurred in the Lethbridge area on August 22-23, 1978, when up to 112 millimetres of rainfall was reported in a 12 to 18 hour period, and caused extensive flood damage to several communities. The Government of Alberta paid in excess of $370,000.00 in compensation for flood damages caused by this storm.

On July 1, 1982, 63 millimetres of rain fell in a 35 minute period, which caused serious flooding in a portion of Lethbridge. Figure 23 shows the rainfall accumulation at the Lethbridge Airport for this storm. The Government of Alberta paid in excess of $340,000.00 in compensation for flood damages caused by this storm.

The Effect of Storage[1]

The Waterton and St. Mary Reservoirs were built to provide water storage for irrigation needs. In the past, these reservoirs have not been operated with flood control as a major consideration. Flood forecasting and operating procedures are now in place, which will optimize the flood control benefits which can be derived from the St. Mary and Waterton Reservoirs. The St. Mary Reservoir was completed in 1952 and the Waterton Reservoir in 1964. The following table lists the historic natural flows and the regulated flows, which would have occurred if the reservoirs were in place and were operated according to the latest flood forecasting and reservoir operating procedures:

Year	Waterton Dam Natural Flood Peak (cfs)	Optimum Regulated Flood Peak (cfs)
1953	15,500	13,500
1964	30,000	18,000
1975	35,000	23,500
1:100	39,000	33,500

Year	St. Mary Dam Natural Flood Peak (cfs)	Optimum Regulated Flood Peak (cfs)
1953	21,500	10,000
1964	37,000	10,000
1975	32,500	16,000
1:100	39,500	22,000

The above information was obtained from Graham (1981). From the above table, it can be seen that these reservoirs can provide some flood reduction for downstream locations.

[1] This section was written by D.R. Graham, River Forecast Centre, Technical Services Division, Alberta Environment.

THE EFFECT OF ICE ON RECORDED STAGES[1]

On most rivers in Alberta the presence of ice cover during the winter affects the stage-discharge relationships. When this occurs at or near a hydrometric station the change in stage due to ice conditions is recorded.

In this report the ice cover period (i.e., the period between the first and last ice) is the time when ice affects the stage-discharge relationships at the hydrometric station.

Freeze-up, or first ice, is the period when the channel progresses from an open water condition to an ice cover. Break-up, or last ice, is the period when the channel ice cover progresses from a solid mass to open water. This process is affected mainly by hydrologic conditions and the characteristics of the ice. Ice jams can occur during the break-up or freeze-up period..

Table 22 gives the dates of first ice and last ice for 19 selected stations in the Oldman River Basin and the South Saskatchewan River at Medicine Hat.

On March 29, 1951 there was a major ice jam on the South Saskatchewan River at Medicine Hat, causing 60 homes to be inundated and 6 families to be evacuated. During this ice jam, the river stage reportedly rose 4.5 metres in a 6-hour period. Attempts were made by the Royal Canadian Air Force to use aerial bombs to blow-up the ice jam. Six bombs were dropped, these bombs were in the 500 to 1000 pound range, they merely made holes in the ice but failed to move the ice jam, Calgary Herald (1951).

[1] This section was written by H. Rickert, River Engineering Branch, Technical Services Division, Alberta Environment.

Many other ice jams have been reported at several different locations over the years. For example, there was flooding in Taber Provincial Park in March 1972, when the Oldman River rose three to five metres in the park grounds. This rapid rise took place in less than six hours, and park personnel had to wade through chest deep water in the early hours of the morning to reach safety. The damage to buildings and property at the Provincial Park was extremely high. Figures 78 and 79 are scenes at Taber Provincial Park in March 1972, after the water level had dropped. During this break-up period, there was also some danger of flooding due to ice jams in the vicinity of Fort MacLeod.

The magnitude, duration, and likelihood of occurrence of ice jams cannot be predicted, but the fact that ice jams can cause substantial increases in river stage in a very short time should be borne in mind.

HISTORICAL FLOOD LEVELS AND FLOOD DAMAGES

Recorded River Stages

Figures 25 to 38 give selected maximum river stage data for 13 stations in the Oldman River Basin and the South Saskatchewan River at Medicine Hat. The highest flood stage recorded at the station is given on each graph, along with a few other selected maximum annual flood stages, which are not necessarily the highest values recorded for the particular station.

It should be noted that all the gauge heights used in these graphs have been derived from the current available rating curve for each hydrometric station. Also, note that all the gauge heights shown on Figures 25 to 38 refer only to the exact hydrometric station location.

Table 23 gives the maximum recorded discharges for selected stations in the Oldman River basin and the South Saskatchewan River at Medicine Hat.

The most recent major flood in the Oldman River Basin occurred in June 1975. At many of the stations this was the largest flood event on record, as shown in Figures 25 to 38. High floods also occurred in 1964, 1953, 1948, 1927, 1915, 1908, 1902, and 1897, however prior to the 1953 flood, meteorologic and hydrometric networks were quite sparse, making flood analyses difficult.

It should be noted that the highest flood ever recorded for the South Saskatchewan River at Medicine Hat was in August 1902, and the highest floods ever recorded for the Waterton River near Waterton Park and the St. Mary River at the International Boundary were in June 1908.

Discussions of events leading to and the results of the 1953, 1964, and 1975 floods have been given by Collier (1965), Warner (1973), and Phinney (1982), respectively.

1915 Flood

In June 1915, flooding occurred along many rivers in Alberta. The level of the Oldman River at Lethbridge rose 0.5 to 1.0 metres between the 26th and 27th of June. In comparison, the Red Deer River rose about 3.7 metres and the Bow River rose approximately 2.7 metres, during the flooding associated with the same weather system.

Antecedent moisture conditions were very high in the basin, as indicated by rainfall records for Pincher Creek and Fort MacLeod. Rain fell almost every day during the two months prior to the high flows of June 25 to 28. A total of 146 millimetres fell in May and June (this is 200% of the normal May/June precipitation in this area).

Heavy rains began June 24, with the maximum precipitation occurring on the 25th. Peak flows at the major stations occurred on June 26 and 27. However, little damage resulted from the flooding since most settlements at that time were above the danger level, Whyte (1916).

1953 Flood

During May and June of 1953, precipitation was very widespread, affecting most of the South Saskatchewan River Basin (Red Deer, Bow, and Oldman Rivers). In contrast to the 1964 and 1975 floods where rainfall occurred as single storm events, the synoptic conditions of the 1953 flood were complex, with five separate rain storms occurring at close intervals between May 24 and June 15.

The first two storms, around May 26 and 30, were centered over the International Boundary and Waterton Park area, and effectively saturated the basin (with a total of 86 millimetres at Mountainview, and 145 millimetres at Waterton Park Headquarters). On June 3, the third storm also produced heavy precipitation (82 millimetres at Mountainview and 110 millimetres at Waterton Park Headquarters). Maximum peaks occurred on most rivers on June 3 and 4.

On June 7 the downstream stations in the basin were severely affected by another intense storm (70 millimetres at Cardston and 115 millimetres at Claresholm). The fifth storm of the series occurred on June 11 to 13. It was spread over a wide area of the foothills, but produced less precipitation (20 millimetres at Pincher Creek) than the previous storms.

The St. Mary Dam had been completed in 1951. Although the spillway was still being constructed when the 1953 flood occurred, the reservoir was able to store some of the flood waters, but not enough to significantly reduce flood flows downstream.

The flooding caused considerable damage to property such as, diversion canals, flood control works, highway bridges, and railway lines, over much of the basin. Total damages of 0.5 million dollars were estimated, Collier (1965). Figures 62 to 73 are photographs which show flooding during the 1953 flood.

1964 Flood

Heavy rainfall on June 7 and 8 in the foothills and mountain areas of Montana and Waterton Park, Alberta, was the major cause of flooding in the Oldman River Basin in 1964. Considerable, antecedent precipitation had primed the basin for high runoff.

May precipitation was far above normal (230 millimetres at Waterton Park Headquarters and 220 millimetres at Birdseye). Snowmelt runoff was delayed due to below normal March, April, and May temperatures, and the snowpack water equivalent was very high. When temperatures rose at the end of May, snowmelt occurred rapidly and the upper Oldman Basin quickly became saturated. Between June 6 and 7, up to 150 millimetres of rain had fallen in the Waterton Park area and over 75 millimetres at many other stations. On June 8, up to 40 millimetres was reported at some stations.

Willow Creek at Nolan and the Crowsnest River at Frank peaked on June 7. The Belly River at Mountainview, Oldman River at Waldron's Corner, Castle River at Beavermines, and the St. Mary River at the International Boundary peaked on June 8. The Waterton River at Waterton Park peaked on June 9 and the Oldman River at Lethbridge peaked on June 10.

Although the Waterton Reservoir was not completed until 1965, storage of some of the flood waters of 1964 was possible. Storage in Lake Sherburne did help to reduce the peak discharge on the Swift Current Creek and the storage in St. Mary Reservoir delayed the peak on the St. Mary River near Lethbridge by approximately 30 hours. As a result, the combined flows of the St. Mary River and Oldman River at Lethbridge were reduced.

Damages attributed to the flood were assessed at 55 million dollars in Montana, and more than 1 million dollars in Alberta. Major flooding was caused by the Waterton, Belly and St. Mary Rivers, and Lee Creek. The townsites of Cardston and Waterton Park, in particular, were severely flooded. Bridges were washed out, farms were flooded, and highways were washed out. Warner (1973) states:

> *"The Waterton Park townsite, which is bordered by Waterton Lake, was the scene of very severe flooding. The lake level rose four feet in a three-hour period early on June 8. Overbank flow from Cameron Creek also added to the flood waters. A brief 70-mph north wind created waves on the lake that smashed boats at the Waterton Lake pier. Main roads leading into the townsite were washed out and 150 residents were evacuated to the Prince of Wales Hotel.*
>
> *Flooding and bridge washouts closed most highways crossing the Belly River. Severe flooding of lowlands along the Belly River forced the evacuation of some 250 people on the Blood Indian*

> *Reserve near Stand Off, Alberta. A Hutterite colony north of Stand Off was also threatened and all residents fled to higher ground. No injuries to those residents were reported but more than 200 head of cattle and 300 sheep were drowned.*
>
> *Lee Creek, which has its source in Glacier National Park, washed out the diversion dam for the municipal water supply and burst the main water supply pipes serving the town of Cardston. Six homes and several commercial buildings were also destroyed."*

Figures 74 to 77 are photographs which show some of the flooding of the 1964 flood.

June 1975 Flood

Between June 15 and 20, 1975, very heavy rainfall in the mountains and foothills area, augmented by snowmelt, resulted in widespread flooding over much of southern Alberta. In what was a typical, heavy, rain-producing storm, a cold low system producing rain in Wyoming and Montana, moved northward into the southern Alberta foothills area. Moderate storm rainfall of up to twelve millimetres began falling on June 15, and by June 18 the storm had increased in intensity and moved further north, centering over the Waterton Park area. The May precipitation had been well above normal in the foothills areas (113 millimetres at Cardston, 135 millimetres at Beavermines), although little rain fell during the first half of June. Temperatures during this time had been normal to above normal and snow was still present at higher elevations. Then, in two days, June 18 and 19, up to 310 millimetres of rain fell at upper elevation stations, with the maximum occurring on the 19th (Figure 24). Rivers and creeks rose very rapidly, with most of them peaking on the 20th (Figures 25 to 38).

Visitors to Waterton Park, the worst hit area, were evacuated on June 19 as Cameron Creek overtopped its banks, the lake rose and the campgrounds, streets, and yards were covered by 0.6 to 0.9 metres of water. Sand-bagging was required along river banks at Lee Creek, Pincher Creek, and Lethbridge. Bridge approaches and parts of roads were washed out. Water supply mains were damaged in several communities, and families were evacuated from other low-lying areas. One person drowned as a result of the flooding.

Agricultural damages were high in some area, these damages included crop losses, soil erosion, buildings, and the loss of livestock. It is estimated that the June 1975 flood caused nearly 2.5 million dollars damage. The damage in the Waterton Parks area was nearly 1 million dollars and the damage in the other areas was about 1.5 million dollars. Figures 80 to 90 are photographs which show some of the 1975 flooding.

"In 1953, the year of the record flood at Lethbridge, an estimated 0.5 million dollars damage occurred in Alberta, and in 1964, the flood damage reached about 1.0 million dollars in Alberta. In 1975 prices, these values approximate 1.0 million and 1.7 million dollars, respectively." Alberta Environment (1976). Therefore, the 1975 flood has caused the greatest monetary loss by a flood in the Oldman River Basin to date.

1975 FLOOD FORECASTING

In any flood situation, the issue of early flood forecasts can help to reduce the extent of the flood damages.

In 1975, the first warning that a storm was posing a serious threat to south-western Alberta was issued by the River Forecast Centre, Alberta Environment, at 1000 MDT June 19, 1975. The news release stated that:

> *"Heavy Rains in the last 48 hours are expected to cause serious flooding in the Oldman River Basin in southwestern Alberta.*
>
> *Between two and four inches of rain had fallen by this morning and more is forecast. Severity of flooding will depend on the amount of rain in the next day.*
>
> *Flooding is particularly likely along the St. Mary, Belly, Waterton, and Castle Rivers and along Pincher and Lee Creeks.*
>
> *Flooding can also be expected along smaller creeks and in other localized situations.*
>
> *If another three inches of rain falls, the floods could reach the record levels of 1964.*
>
> *Rain is still falling in the area."*

Alberta Environment issued the following flood bulletin on the morning of June 20, 1975.

> *"Several of the smaller streams in the southwest portion of the province reached their flood peaks this morning as the rain which has been falling in the area began to taper off.*

Lee Creek at Cardston and the St. Mary River at the U.S. Border both peaked slightly below the record 1964 flood levels.

Further downstream, water levels will continue to rise until peaks are reached later in the day.

The streams flowing into Waterton Lake have peaked but the lake will continue to rise until late today. The final stage of the lake should be about one foot above the 1964 level.

If the weather continues to clear as forecast, the creeks and streams will drop significantly after their peaks are reached."

At 1000 M.D.T on June 21, 1975, Alberta Environment issued another flood bulletin:

"At ten O'Clock this morning the flood stage on the Oldman River at Lethbridge is 20.5 feet.

The flood is expected to peak later today at a stage of about two feet higher than it is right now.

The flood stage is dropping on the following rivers: St. Mary River, Lee Creek, Belly River, Waterton River, Pincher Creek, Castle River, and Crowsnest River."

The final bulletin for the Oldman River Basin was issued by Alberta Environment about 1000 MDT, June 22, 1975.

"Peak on South Saskatchewan River at Medicine Hat is expected around midnight today, Sunday, June 22, at a stage of about 29 feet.

The stage at Medicine Hat, now at 10:00 a.m., is about 20 feet.

The Oldman River at Lethbridge peaked last night around 10:00 p.m. at a stage of about 24 feet. By ten O'Clock this morning the river stage at Lethbridge had dropped by three feet."

The above news releases were issued via Canadian Press to the various news media in the Province. Radio stations in southern Alberta aired these releases immediately. In addition, Alberta Disaster Services were briefed. Alberta Disaster Services also warned various municipalities about the flood potential.

The flood forecasts and early warnings provided sufficient forewarning to enable most communities to carry out sandbagging and emergency dyking in order to protect homes, buildings, bridges, and other structures. Livestock was moved to higher locations.

Although the flood damages have been reported at 2.5 million dollars, it is estimated that emergency measures may have prevented several million dollars of additional flood damage.

ADDITIONAL FLOOD-RELATED DATA[1]

General

In addition to the streamflow data, compiled from Water Survey of Canada records, there are other flood-related data which have been compiled by the River Engineering Branch, Technical Services Division, Alberta Environment. This section provides an index of additional flood information for the Oldman River Basin. This information was previously published in 1977, in a "Flood Information Index", Quazi (1977), and is updated for this report.

Flood-related data are classified under four main categories - Historical, Aerial Flood Photography, High Water Mark Surveys and Floodplain Studies.

Historical information

Historical flood information, in the form of newspaper clippings, are available from the various newspapers located within the Oldman River Basin. A list of the years for which newspaper clippings are available are included below. During the years which are underlined, abnormally high flows were recorded in some areas.

River and Vicinity	Flooding Years
Oldman River in the vicinity of Lethbridge and Fort MacLeod	1916, 1923, 1929, 1937, 1942, 1947-48, 1952-53, 1955, 1964, 1972, 1975
Pincher Creek and Lee Creek	1981

[1] This section was written by H. Rickert, River Engineering Branch, Technical Services Division, Alberta Environment.

Aerial flood photography

The following provides a summary of aerial photography flown during, or immediately following, a flood in the Oldman River Basin:

1975 Aerial Flood Photography

Name and Date	Location	Scale	AS No.
Lethbridge Flood (21/06/75)	Near Lethbridge	1:12,000	1384
Oldman River (21/06/75)	Near Ft. MacLeod	1:12,000	1384
Belly River (21/06/75)	Near Standoff	1:12,000	1384

Additional information or enquiries can be made to:

Alberta Energy and Natural Resources
Technical Division
Resource Evaluation Branch

High water mark surveys

Actual markings left during the peak flow for any flood were located and surveyed. The results of these surveys were then compiled into report form. For the majority of locations, the surveys were tied into geodetic datum and permanent benchmarks were established to enable a rapid re-survey during future floods. The following is a list of the high water mark survey reports completed by the Technical Services Division, Alberta Department of the Environment.

The reports completed to date are:

Oldman River, Crowsnest River (Crowsnest tributaries - Gold Creek, Lyons Creek, York Creek, Nez Perce Creek), Belly River, Waterton River, Cameron Creek, Lee Creek, South Saskatchewan River.

Report title: "High Water Mark Coverage 1975 Flood" - Oldman and South Saskatchewan River Basins H. Rickert, CET. and G. Holfeld, July 1975.

Kettles Creek, Pincher Creek, Lee Creek

Report title: "1981 High Water Mark Report" - Bow/Elbow River, Sheep River at Black Diamond/Turner Valley and Okotoks, Bragg Creek, Nose Creek, Kettles Creek, Pincher Creek, Lee Creek - H. Rickert, CET. and S. Vincic, CET September 1981.

In addition to the above, high water marks located during various floods on the Oldman and South Saskatchewan Rivers are included on the longitudinal profile (Figure 106) of the Oldman and South Saskatchewan Rivers. This profile includes the elevations of the approximate river bed, apparent bedrock, water levels on selected dates, high water marks from some of the larger floods, and the decks of some of the bridges.

Enquiries regarding high water levels for specific flood events should be made to: River Engineering Branch
Technical Services Division
Alberta Department of the Environment

Floodplain studies

A floodplain study for any specific location provides documentation on the historical flooding, hydrology, and a floodplain analysis for that area. Floodplains are delineated on airphoto mosaics or topographic maps showing the extent of flooding, and in most studies, flood profiles are also plotted. Floodplain studies in the Oldman River Basin completed by the River Engineering Branch, Alberta Environment, are listed below.

Floodplain Studies

River	Location	Year	Author
South Saskatchewan	Medicine Hat	1976	M.E. Quazi, P. Eng.
Oldman River	Lethbridge	1977	G. Beckstead, P. Eng. and L. Garner
Lee Creek	Cardston	1978	D. Outhet

River	Location	Year	Author
Crowsnest River	Crowsnest Pass (Coleman/Blairmore/ Frank)	1981	G. Beckstead, P.Eng. and L. Penner
Pincher Creek	Pincher Creek	1980	G. Beckstead, P. Eng. and J. Jackson

Additional information about these studies can be obtained from:

River Engineering Branch
Technical Services Division
Alberta Department of the Environment

Copies of the completed reports are available for public perusal in the Alberta Department of Environment Library.

FLOOD FREQUENCY ANALYSES[1]

The previous sections have demonstrated that there is a high degree of variability in the magnitude of flows, which may be experienced from one site to the next, as well as from one year to the next. Because of this variability, it is seldom economical to design engineering works to protect against the maximum flow which may be expected to occur. Rather, a compromise has to be reached between the average annual damages resulting from occasional floods and the cost of providing a greater level of protection. Decisions as to the optimum level of compromise are made on the basis of knowledge of the probability of future occurrences. Probabilities of future occurrences are defined by fitting flood data to a selected frequency distribution.

There are numerous frequency distributions for the fitting of flood data. However, comparisons of probability estimates, from previous in-house studies, of the natural and log-transform maximum likelihood Gumbel, Normal, Three Parameter Gamma, and method of moments Three Parameter Pearson distributions, indicated that the method of moments Pearson III distribution is most frequently the best approximation of the true distribution of the observed annual flow series. Therefore, the method of moments Pearson III frequency distribution was selected as the basic distribution to describe the annual flood series, and was utilized in all subsequent frequency analyses. It should be noted, that the underlying assumption in any frequency analyses is that the available data is a reliable and representative time sample of random, homogeneous events.

For the purpose of this study, the following three categories of flood data were recognized and utilized in the evaluation of flood probabilities: systematic records, historic data, and comparisons with similar watersheds.

[1] This section was written by S. Figliuzzi, Hydrology Branch, Technical Services Division, Alberta Environment.

Due to the limited number of data samples, a degree of uncertainty is inherent in any flood frequency analysis. Therefore, the frequency curve provides only an estimate of the population curve and not an exact representation. The level of uncertainty in the estimated exceedance probability of a selected discharge or in the discharge of a specified exceedance probability, is reflected by the establishment of confidence limits. In this study, all confidence limits were established by the procedure recommended by the U.S. Water Resources Council (1977). Records from stations, with a relatively short period of record, were extended by means of regression with a nearby station having a longer period of record. In such cases, the sample size used to compute the confidence bands was assumed to be equal to the equivalent years of record of the regression, rather than the length of either the short or long-term record, Hardison (1969).

Frequency analyses, for hydrometric stations where the sole regulation consisted of relatively minor upstream diversion, were carried out without any adjustments to the recorded data. Station 05AB002 and 05AB021 (Willow Creek near Nolan and near Claresholm), which have been regulated since 1966, were found to have negligible peak flow attenuation and their frequencies were established on the basis of the entire period of record. For station 05AD028 (Waterton River near Glenwood) the period of record was extended to include 1916 to 1930 and 1935 to 1966 by directly transferring data from station 05AD008 (Waterton River near Stand Off). The natural mean daily flows and regulated flows (for the present operational rule curves) were then re-constructed for years of record using the U.S. Corps of Engineers Streamflow Synthesis and Reservoir Regulation (SSARR) model. Frequency curves for station 05AD028 were then computed for both the natural and regulated flow conditions. Frequency analyses were not carried out for station 05AD007, Oldman River near Lethbridge, due to the high variation in both the degree of regulation, and the operational procedures over the recorded period. The resultant frequency curves for the Waterton River near Glenwood, Willow Creek near Nolan and Claresholm, and for all other streams, are shown in Figures 39 to 57. If refinements were made to the basic frequency curves, they were noted in the appropriate figures.

The instantaneous flow series is relatively incomplete when compared with the mean daily flow series. No attempt has been made to determine the frequency curves for instantaneous flows. The ratio of the average peak flow to mean daily flow has been determined for each of the stations analyzed and is presented in Table 24 for 19 of the selected stations used in this report.

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TABLE 1

PINCHER CREEK AT PINCHER CREEK - STATION NO. 05AA004

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1910			2.8	MAY 20
1911			30.0	SEP 4
1912			4.7	APR 11
1913			7.9	APR 16
1914			6.1	OCT 16
1915			27.6	JUN 3
1916			11.2	JUL 2
1917			18.1	JUN 11
1918			3.1	JUN 11
1919			3.8	MAY 28
1920			18.6	MAY 8
1921			5.2	MAY 21
1922			9.3	MAY 17
1923	66.5	JUN 1	44.2	JUN 1
1924	19.1	12:00 MST, JUN 7	18.0	JUN 7
1925	7.4	08:00 MST, APR 23	7.1	APR 23
1926	7.8	08:00 MST, JUN 21	7.1	JUN 21
1927			38.2	MAY 29
1928	25.9	08:00 MST, JUN 18	21.7	JUN 18
1929	23.8	18:00 MST, JUN 3	21.3	JUN 3
1930	7.4	18:00 MST, JUN 3	6.9	MAY 4
1936			7.6	APR 11
1966	15.7	20:00 MST, JUN 4	12.5	JUN 4
1967	53.0	20:00 MST, MAY 17	29.4	MAY 17
1968	8.2	22:03 MST, SEP 25	6.9	SEP 25
1969	49.8	09:15 MST, JUN 26	34.5	JUN 26

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 1 cont'd) PINCHER CREEK AT PINCHER CREEK - STATION NO. 05AA004

YEAR	MAXIMUM INSTANTANEOUS m^3/s	MAXIMUM INSTANTANEOUS TIME AND DATE	MAXIMUM DAILY m^3/s	MAXIMUM DAILY DATE
1970	46.4	17:00 MST, JUN 13	23.1	JUN 13
1971	6.6	15:30 MST, MAY 31	6.3	MAY 31
1972	40.2	10:40 MST, MAY 25	19.5	MAY 25
1973	4.3	21:30 MST, MAY 18	4.1	MAY 18
1974	24.5	18:40 MST, MAR 17	10.0	MAY 1
1975	172	02:20 MST, JUN 20*	82.4	JUN 20**
1976			4.4	MAY 11
1977	0.8	14:30 MST, MAY 11	0.8	MAY 12
1978	7.4	21:40 MST, MAY 31	4.6	JUN 1
1979	5.4	01:40 MST, MAY 17	5.1	MAY 27
1980	33.7	17:30 MST, MAY 26	22.0	MAY 26
1981	71.3	08:10 MST, MAY 22	38.7	MAY 22
1982	4.3	03:20 MST, JUN 7	3.9	JUN 7

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 2

CROWSNEST RIVER AT FRANK - STATION NO. 05AA008

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1911			39.4	JUN 2
1912			20.1	JUN 16
1913			25.1	MAY 29
1914			17.4	MAY 3
1915			34.8	MAY 2
1916			47.6	JUN 20
1917			46.4	MAY 15
1918			24.4	JUN 11
1919			25.5	MAY 29
1950	29.7	23:00 MST, MAY 27	28.6	MAY 22
1951	47.0	17:00 MST, MAY 14	44.7	MAY 14
1952	27.1	22:00 MST, APR 26	25.7	APR 27
1953	73.9	00:30 MST, JUN 9*	65.7	JUN 9**
1954	65.1	23:00 MST, MAY 19	58.9	MAY 20
1955	25.8	23:00 MST, MAY 19	22.7	JUN 13
1956	57.2	22:00 MST, MAY 20	54.1	MAY 21
1957	31.7	20:00 MST, MAY 5	28.6	MAY 5
1958	30.6	20:00 MST, MAY 12	25.9	MAY 13
1959	37.1	20:00 MST, JUN 5	36.0	JUN 5
1960	25.2	02:00 MST, MAY 13	24.0	MAY 13
1961	62.9	01:00 MST, MAY 27	58.0	MAY 27
1962	17.0	23:00 MST, APR 24	15.5	MAY 24
1963	29.2	16:00 MST, JUN 30	28.6	JUN 30
1964	50.4	20:00 MST, JUN 7	47.6	JUN 8
1965	70.8	01:00 MST, JUN 18	59.7	JUN 18
1966	30.9	22:00 MST, MAY 11	27.2	JUN 5
1967			47.0	MAY 31
1968			48.7	MAY 23
1969	29.7	09:00 MST, JUN 26	28.9	JUN 29

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 2 cont'd) CROWSNEST RIVER AT FRANK - STATION NO. 05AA008

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1970	20.5	22:30 MST, MAY 23	19.7	MAY 24
1971	35.1	20:00 MST, MAY 27	34.0	MAY 28
1972	62.6	21:40 MST, MAY 31	59.7	JUN 1
1973	21.3	23:00 MST, JUN 8	19.5	MAY 18
1974	40.8	21:00 MST, MAY 26	38.8	JUN 17
1975			48.7	JUN 20
1976	33.7	15:00 MST, AUG 8	27.7	AUG 9
1977	7.8	08:30 MST, MAY 11	7.4	MAY 11
1978	22.3	06:30 MST, JUN 6	21.9	JUN 6
1979	33.2	01:30 MST, MAY 27	30.1	MAY 27
1980	23.6	04:25 MST, APR 30	21.7	APR 30
1981	43.1	23:40 MST, MAY 25	41.6	MAY 26
1982			16.8	MAY 26

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 3

CASTLE RIVER NEAR BEAVER MINES - STATION NO. 05AA022

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1945	145	19:00 MST, JUN 6	142	JUN 6
1946			96.8	MAY 29
1947			143	MAY 10
1948	442	14:00 MST, MAY 22	362	MAY 23
1949	73.9	16:30 MST, MAY 13	71.9	MAY 13
1950	128	03:00 MST, JUN 16	122	JUN 16
1951	145	16:00 MST, MAY 14	136	MAY 14
1952	92.3	22:30 MST, APR 27	89.5	APR 28
1953	283	20:00 MST, JUN 8	257	JUN 8
1954	215	22:00 MST, MAY 19	187	MAY 20
1955	124	23:59 MST, MAY 19	114	JUN 14
1956	183	03:00 MST, MAY 21	174	MAY 21
1957	115	05:00 MST, MAY 21	106	MAY 21
1958	144	21:00 MST, MAY 12	125	MAY 12
1959	138	23:00 MST, JUN 5	136	JUN 5
1960	119	05:00 MST, MAY 13	111	MAY 13
1961	176	06:00 MST, MAY 27	170	MAY 27
1962	67.4	08:00 MST, APR 25	65.7	APR 25
1963	89.2	07:00 MST, JUN 30	87.2	JUN 30
1964	510	21:00 MST, JUN 8	360	JUN 8
1965	294	19:00 MST, JUN 17	219	JUN 18
1966	111	21:30 MST, MAY 10	100	MAY 29
1967	227	22:00 MST, MAY 22	208	MAY 22
1968	157	01:00 MST, MAY 23	142	MAY 23
1969	159	08:23 MST, JUN 26	144	JUN 26

---

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 3 cont'd) CASTLE RIVER NEAR BEAVER MINES - STATION NO. 05AA022

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1970	210	21:00 MST, JUN 13	170	JUN 14
1971	125	06:00 MST, MAY 28	120	MAY 28
1972	213	JUN 1	201	JUN 1
1973	96.6	03:30 MST, MAY 18	94.0	MAY 18
1974	171	04:20 MST, JUN 17	167	JUN 17
1975	736	02:00 MST, JUN 20*	535	JUN 20**
1976	124	10:30 MST, MAY 11	119	MAY 11
1977	35.1	18:00 MST, MAY 11	33.4	MAY 11
1978	99.1	12:20 MST, JUN 6	96.3	JUN 6
1979	113	04:35 MST, MAY 27	107	MAY 25
1980	131	17:30 MST, MAY 26	112	MAY 26
1981			150	MAY 22
1982	101	11:20 MST, MAY 26	97.7	MAY 26

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 4

OLDMAN RIVER NEAR WALDRON'S CORNER - STATION NO. 05AA023

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1950	79.6	01:00 MST, MAY 28	72.8	MAY 28
1951	137	15:00 MST, JUN 15	125	JUN 15
1952	71.4	14:30 MST, JUN 12	51.0	APR 27
1953	453	23:00 MST, JUN 8*	337	JUN 9**
1954	149	23:00 MST, MAY 19	127	MAY 20
1955	99.1	01:00 MST, MAY 20	74.5	MAY 20
1956	149	01:00 MST, MAY 21	136	MAY 21
1957	77.6	23:00 MST, MAY 5	71.4	MAY 7
1958	79.9	21:00 MST, MAY 12	66.8	MAY 12
1959	110	01:00 MST, JUN 6	103	JUN 5
1960	84.1	01:00 MST, MAY 13	74.2	MAY 12
1961	177	07:00 MST, MAY 27	162	MAY 27
1962	51.0	02:00 MST, MAY 20	49.3	MAY 20
1963	212	JUN 30	198	JUN 30
1964	140	12:00 MST, JUN 8	131	JUN 8
1965	173	06:00 MST, JUN 18	155	JUN 18
1966	100	01:00 MST, JUN 5	94.6	JUN 5
1967	286	22:00 MST, MAY 30	242	MAY 31
1968	92.0	03:14 MST, MAY 23	84.1	MAY 23
1969	140	02:13 MST, JUN 26	129	JUN 26
1970	104	22:25 MST, JUN 13	91.5	JUN 14
1971	106	23:00 MST, JUN 6	102	JUN 6
1972	245	01:15 MST, JUN 1	217	JUN 1
1973	74.8	01:00 MST, MAY 18	63.4	MAY 18
1974	174	04:00 MST, JUN 17	162	JUN 17
1975	368	04:30 MST, JUN 20	286	JUN 20
1976	250	00:50 MST, AUG 6	173	AUG 6
1977	28.6	10:15 MST, MAY 11	25.4	MAY 11
1978	113	01:30 MST, JUN 6	102	JUN 6
1979	109	01:30 MST, MAY 27	94.0	MAY 27
1980	67.0	MAY 26	62.0	MAY 26
1981	221	02:10 MST, MAY 26	182	MAY 26
1982	78.4	00:17 MST, JUN 16	71.6	JUN 16

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 5

OLDMAN RIVER NEAR BROCKET - STATION NO. 05AA024

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1966	263	07:30 MST, JUN 5	252	JUN 5
1967	739	22:00 MST, MAY 30	634	MAY 31
1968	357	13:00 MST, MAY 23	297	MAY 23
1969	538	14:30 MST, JUN 26	467	JUN 26
1970	402	01:46 MST, JUN 14	351	JUN 14
1971	331	09:30 MST, MAY 28	314	MAY 28
1972	716	JUN 1	651	JUN 1
1973	212	10:20 MST, MAY 18	199	MAY 18
1974	408	08:35 MST, JUN 18	374	JUN 17
1975	1560	07:30 MST, JUN 20*	1220	JUN 20**
1976	326	06:20 MST, AUG 6	269	AUG 6
1977	77.0	19:45 MST, MAY 11	68.5	MAY 12
1978	247	11:25 MST, JUN 6	238	JUN 6
1979	282	06:00 MST, MAY 27	269	MAY 27
1980	272	00:00 MST, MAY 27	249	MAY 27
1981	519	14:30 MST, MAY 22	477	MAY 22
1982	189	06:05 MST, MAY 26	181	MAY 26

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 6

CASTLE RIVER AT RANGER STATION - STATION NO. 05AA028

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1967	94.3	01:00 MST, MAY 23	88.3	MAY 22
1968	59.2	03:20 MST, MAY 23	55.2	MAY 23
1969	62.9	20:31 MST, JUN 26	58.0	JUN 27
1970	130	17:30 MST, JUN 13	103	JUN 14
1971	80.4	08:00 MST, MAY 28	76.2	MAY 28
1972	116	10:00 MST, JUN 1	109	JUN 1
1973	56.9	05:10 MST, MAY 18	54.9	MAY 18
1974	97.7	06:40 MST, JUN 18	94.6	JUN 17
1975	402	00:20 MST, JUN 20*	297	JUN 20**
1976	75.6	09:30 MST, MAY 11	70.5	MAY 11
1977	20.8	14:20 MST, MAY 11	19.9	MAY 11
1978	61.2	10:15 MST, JUN 6	58.6	JUN 6
1979	65.8	08:10 MST, MAY 27	62.3	MAY 27
1980	102	13:20 MST, MAY 26	84.7	MAY 26
1981	102	00:35 MST, MAY 23	91.7	MAY 22
1982	58.7	23:35 MST, JUN 14	58.0	JUN 14

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 7

WILLOW CREEK NEAR NOLAN - STATION NO. 05AB002

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1910			2.3	SEP 21
1911			41.9	SEP 5
1912			38.5	JUN 16
1913			21.4	APR 12
1914			12.7	APR 6
1915			112	JUN 26
1916			58.0	JUN 10
1917			82.4	MAY 28
1918			11.4	MAR 26
1919			11.7	APR 1
1920			87.2	MAY 9
1921			22.4	APR 3
1922			24.5	APR 22
1923			203	JUN 2
1942	552	12:00 MST, MAY 12	317	MAY 12
1943			77.9	APR 3
1944			9.5	APR 5
1945			37.9	JUN 7
1946	60.6	JUN 8	58.0	JUN 8
1947			27.4	JUN 12
1948			101	MAY 23
1949			16.7	MAY 22
1950	9.2	10:00 MST, MAY 16	9.0	MAY 28
1951			90.6	JUN 24
1952			60.9	APR 7
1953	592	10:00 MST, JUN 9*	416	JUN 9**
1954			34.8	MAY 12
1955	107	16:00 MST, MAY 19	101	MAY 20
1956			31.7	JUL 5
1957			15.3	MAY 9
1958			52.1	APR 14
1959	28.9	15:00 MST, JUN 28	28.0	JUN 28

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 7 cont'd) WILLOW CREEK NEAR NOLAN - STATION NO. 05AB002

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1960	34.8	16:00 MST, MAR 20	29.2	MAR 19
1961	10.7	01:00 MST, MAY 18	9.7	MAY 17
1962	51.8	14:00 MST, APR 5	37.1	APR 5
1963	368	JUN 30	328	JUN 30
1964	50.1	22:00 MST, MAY 7	37.1	MAY 7
1965	54.1	22:00 MST, JUN 18	37.7	JUN 19
1966	41.9	02:00 MST, JUN 6	36.2	JUN 6
1967			99.7	JUN 2
1968	9.7	02:00 MST, SEP 27	9.3	SEP 27
1969	120	13:59 MST, JUN 30	114	JUN 30
1970			43.0	JUN 15
1971	24.1	12:30 MST, JUN 7	22.5	JUN 8
1972	87.2	18:00 MST, MAR 11	47.3	MAR 18
1973	43.0	03:20 MST, MAY 27	37.4	MAY 27
1974	37.9	17:50 MST, MAY 20	34.5	MAY 28
1975	101	08:30 MST, JUN 21	94.0	JUN 21
1976	42.2	13:40 MST, AUG 9	35.7	AUG 9
1977	10.3	12:05 MST, APR 6	9.2	APR 6
1978	37.1	04:30 MST, JUN 1	36.0	JUN 1
1979	23.3	03:30 MST, MAY 18	22.7	MAY 18
1980	16.2	14:15 MST, MAY 28	15.7	MAY 28
1981	68.2	00:25 MST, JUN 15	62.4	MAY 23
1982	11.7	08:30 MST, JUN 7	10.9	JUN 7

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 8

OLDMAN RIVER NEAR FORT MACLEOD - STATION NO. 05AB007

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1911			467	MAY 16
1912			306	JUN 16
1913			385	MAY 29
1914			167	JUN 5
1915			292	JUN 26
1916			609	JUN 21
1917	340	JUN 10*	331	JUN 10
1918			237	JUN 12
1919			261	MAY 28
1920	283	JUN 18	276	JUN 18
1921			252	MAY 26
1922	282	JUN 6	271	JUN 6
1923			1990	JUN 1**
1924			197	JUN 9
1925			272	MAY 22
1926			109	JUN 23
1927			493	JUN 12
1928			394	JUL 1
1929			671	JUN 4
1930			187	MAY 31
1934			541	JUN 8
1935			186	MAY 24
1936			135	MAY 15
1937			391	JUN 13
1938			445	MAY 26
1939			242	JUN 17
1940			164	MAY 12
1941			76.7	JUN 3
1942			1060	MAY 12
1943			199	JUN 18
1944			49.6	JUN 28
1945			411	JUN 7
1946			238	MAY 29
1947			303	MAY 11
1948			1100	JUN 18

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 9

WILLOW CREEK NEAR CLARESHOLM - STATION NO. 05AB021

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1944	5.8	17:40 MST, APR 4	5.5	APR 4
1945	36.2	09:00 MST, JUN 7	35.7	JUN 28
1946			52.1	JUN 7
1947	22.7	17:00 MST, JUN 11	21.1	JUN 11
1948	76.7	17:00 MST, MAY 23	71.9	MAY 23
1949	11.4	16:50 MST, MAY 22	10.6	MAY 23
1950	9.3	17:00 MST, MAY 13	8.6	MAY 16
1951	121	JUN 24	85.0	JUN 24
1952			35.1	APR 7
1953	283	06:00 MST, JUN 9*	234	JUN 9**
1954	37.1	08:30 MST, MAY 12	34.8	MAY 12
1955	92.6	07:00 MST, MAY 19	73.9	MAY 19
1956	38.2	08:20 MST, JUL 4	33.4	JUL 4
1957	14.6	16:00 MST, APR 30	13.3	MAY 2
1958	36.2	07:50 MST, APR 14	27.6	APR 14
1959	17.5	12:00 MST, MAY 28	16.7	MAY 28
1960			26.1	MAR 20
1961			7.5	MAY 25
1962	45.9	03:00 MST, APR 5	30.3	APR 5
1963	255	JUN 29	213	JUN 30
1964			32.6	MAY 7
1965			37.4	JUN 18
1966			33.7	JUN 5
1967			81.3	MAY 31
1968			9.9	SEP 28
1969	105	16:30 MST, JUL 1	92.6	JUL 1

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 9 cont'd) WILLOW CREEK NEAR CLARESHOLM - STATION NO. 05AB021

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1970			47.6	JUN 14
1971			22.7	JUN 7
1972			37.7	MAY 26
1973	44.5	16:00 MDT, MAY 26	30.9	MAY 27
1974	33.7	07:10 MST, MAY 21	32.3	MAY 21
1975	90.3	22:00 MST, JUN 20	64.0	JUN 21
1976			32.0	AUG 6
1977			7.8	APR 5
1978			36.2	MAY 18
1979			18.3	MAY 17
1980			12.9	MAY 27
1981			59.2	JUN 14
1982			7.9	JUN 7

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 10

BELLY RIVER NEAR STAND OFF - STATION NO. 05AD002

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1913			84.1	MAY 29
1914			37.9	JUN 4
1915			76.5	JUN 26
1916			93.2	JUN 28
1917			85.8	JUN 12
1918			51.8	JUN 13
1919			43.9	MAY 29
1920			54.4	JUN 16
1921			53.2	MAY 26
1922			60.3	JUN 6
1923	76.7	JUN 2	69.7	JUN 2
1924			56.6	JUN 8
1925	57.2	MAY 23	55.5	MAY 22
1926			34.8	OCT 18
1927			124	MAY 30
1928			105	JUL 2
1929			60.9	JUN 4
1930			46.7	MAY 22
1949			36.5	MAY 29
1950	64.3	12:00 MST, JUN 22	62.0	JUN 23
1951	272	04:00 MST, JUN 25	223	JUN 25
1952	59.5	01:00 MST, APR 2	51.0	APR 1
1953	303	03:00 MST, JUN 9	273	JUN 9
1954	70.2	20:00 MST, MAY 20	69.7	MAY 21
1955	142	09:00 MST, MAY 19	112	MAY 19
1956	65.1	20:00 MST, MAY 22	64.3	MAY 22
1957	58.9	10:00 MST, MAY 15	57.2	MAY 15
1958	55.5	23:00 MST, JUN 10	51.0	JUN 11
1959	59.7	19:00 MST, JUN 16	56.6	JUN 7

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 10 cont'd) BELLY RIVER NEAR STAND OFF - STATION NO. 05AD002

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1960	95.7	09:00 MST, MAR 19	42.2	JUN 4
1961	58.3	13:00 MST, MAY 31	51.8	MAY 31
1962			22.0	APR 26
1963	16.7	16:00 MST, JUL 7	16.2	JUL 8
1964	331	08:00 MST, JUN 9	292	JUN 9**
1965	69.4	02:00 MST, JUN 18	67.1	JUN 20
1966			77.9	JUN 5
1967	77.6	16:30 MST, MAY 24	75.3	MAY 24
1968	35.1	16:00 MST, JUN 4	34.5	JUN 4
1969	88.6	02:30 MST, JUN 27	80.1	JUN 27
1970	137	12:10 MST, JUN 14	124	JUN 14
1971	45.0	03:00 MST, MAY 29	44.5	MAY 29
1972	65.4	21:15 MST, JUN 2	63.7	JUN 2
1973	25.8	22:10 MST, MAY 19	24.9	MAY 20
1974	63.1	20:00 MST, JUN 18	60.9	JUN 18
1975	394	19:30 MST, JUN 20*	267	JUN 21
1976	48.4	01:40 MST, MAY 12	47.0	MAY 12
1977	5.5	11:30 MST, APR 7	5.2	APR 8
1978	40.8	08:30 MST, JUN 7	39.9	JUN 7
1979	56.8	12:05 MST, MAY 28	55.0	MAY 28
1980	119	09:50 MST, MAY 27	103	MAY 27
1981	153	18:40 MST, MAY 22	115	MAY 22
1982	46.9	09:30 MST, JUN 15	46.2	JUN 15

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

TABLE 11

WATERTON RIVER NEAR WATERTON PARK - STATION NO. 05AD003

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1908			680	JUN 6**
1909			182	JUN 3
1910			83.0	JUN 1
1911			116	JUN 15
1912			71.9	MAY 18
1913			147	MAY 29
1914			82.4	JUN 4
1915			60.6	JUN 6
1916			206	JUN 19
1917			130	MAY 26
1918			127	JUN 13
1919			116	MAY 24
1920			130	JUN 17
1921			133	MAY 28
1922			144	JUN 5
1923			155	JUN 2
1924			121	JUN 14
1925			114	MAY 23
1926			50.1	OCT 19
1927			165	JUN 10
1928			131	MAY 26
1929			115	MAY 25
1930			79.9	MAY 22
1948			171	JUN 18
1949	94.0	20:00 MST, MAY 17	93.4	MAY 17

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 11 cont'd) WATERTON RIVER NEAR WATERTON PARK - STATION NO. 05AD003

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1950	148	12:00 MST, JUN 22	146	JUN 22
1951	123	15:00 MST, JUN 16	121	JUN 16
1952	73.1	10:00 MST, MAY 21	72.2	MAY 21
1953	214	21:00 MST, JUN 4	200	JUN 4
1954	150	12:00 MST, MAY 21	150	MAY 21
1955	127	06:00 MST, JUN 25	126	JUN 25
1956	138	23:00 MST, MAY 22	138	MAY 22
1957	113	15:00 MST, MAY 15	111	MAY 8
1958	107	08:00 MST, MAY 25	106	MAY 25
1959	141	21:00 MST, JUN 6	137	JUN 6
1960	111	20:00 MST, JUN 4	108	JUN 4
1961	150	23:30 MST, MAY 27	144	MAY 27
1962	77.3	17:00 MST, JUN 14	75.9	JUN 18
1963	131	08:00 MST, JUN 11	128	JUN 11
1964	728	04:00 MST, JUN 9*	643	JUN 9
1965	159	21:30 MST, JUN 19	155	JUN 19
1966	116	07:00 MST, JUN 1	114	JUN 1
1967	136	08:30 MST, MAY 24	133	MAY 24
1968	99.1	16:30 MST, JUN 4	97.1	JUN 4
1969	118	08:30 MST, JUN 8	116	JUN 8
1970	179	08:00 MST, JUN 14	176	JUN 14
1971	121	06:00 MST, MAY 29	119	MAY 29
1972	169	13:30 MST, JUN 2	167	JUN 2
1973	102	09:45 MST, MAY 20	101	MAY 20
1974	182	14:40 MST, JUN 18	181	JUN 18
1975	501	11:55 MST, JUN 20	467	JUN 20
1976	104	04:40 MST, MAY 12	101	MAY 12
1977	51.3	14:15 MST, JUN 9	50.4	JUN 9
1978	117	00:10 MST, JUN 10	113	JUN 9
1979	111	23:25 MST, MAY 27	109	MAY 27
1980	155	08:35 MST, MAY 27	150	MAY 27
1981	157	20:25 MST, MAY 23	153	MAY 23
1982	114	02:50 MST, JUN 17	113	JUN 17

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 12

BELLY RIVER NEAR MOUNTAIN VIEW - STATION NO. 05AD005

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1912			33.4	MAY 17
1913			58.6	MAY 29
1914			38.8	JUN 14
1915			38.8	JUN 3
1916			77.3	JUN 21
1917			87.8	JUN 11
1918			46.4	JUN 11
1919			54.7	MAY 29
1920			54.7	JUN 16
1921			49.0	JUN 8
1922			57.8	JUN 6
1923			63.1	JUN 2
1924			42.5	JUN 16
1925			57.5	MAY 23
1926			33.7	OCT 17
1927			75.6	JUN 11
1928			57.8	MAY 25
1929			39.6	JUN 3
1930			38.5	MAY 22
1931			36.8	MAY 16
1932			51.0	MAY 22
1933			54.4	JUN 17
1934			79.9	JUN 7
1935			46.4	MAY 24
1936			36.8	MAY 15
1937			118	JUN 13
1938			58.6	MAY 26
1939			28.6	APR 30

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 12 cont'd) BELLY RIVER NEAR MOUNTAIN VIEW - STATION NO. 05AD005

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1940			30.6	MAY 12
1941			26.5	JUN 29
1942			71.1	JUN 6
1943			54.1	JUN 18
1944	29.7	16:00 MST, JUN 27	26.6	MAY 18
1945			47.6	JUN 4
1946			43.6	MAY 28
1947			40.2	MAY 3
1948	91.2	15:15 MST, JUN 17	88.1	JUN 17
1949	37.7	07:00 MST, MAY 28	37.1	MAY 28
1950	62.6	10:00 MST, JUN 22	61.2	JUN 22
1951	85.5	12:00 MST, JUN 24	69.1	JUN 24
1952	28.9	17:00 MST, JUN 12	27.0	MAY 20
1953	127	04:00 MST, JUN 4	120	JUN 4
1954	69.9	05:00 MST, MAY 20	68.5	MAY 20
1955	60.6	10:00 MST, JUN 25	58.9	JUN 25
1956	61.7	05:00 MST, MAY 22	60.9	MAY 22
1957	56.6	04:00 MST, MAY 14	55.2	MAY 14
1958	53.8	08:50 MST, JUN 10	51.3	JUN 10
1959	55.5	03:00 MST, JUN 6	54.1	JUN 6
1960	43.9	06:00 MST, JUN 4	43.0	JUN 4
1961	55.2	21:00 MST, MAY 27	54.7	MAY 27
1962	32.0	12:00 MST, JUN 14	31.4	JUN 14
1963	51.3	13:00 MST, JUN 10	47.9	JUN 10
1964	464	19:00 MST, JUN 8*	303	JUN 8
1965	71.9	19:00 MST, JUN 19	69.1	JUN 19
1966	53.5	18:00 MST, JUN 4	50.1	JUN 4
1967	66.0	23:30 MST, MAY 23	62.9	MAY 23
1968	43.9	02:00 MST, JUN 4	41.9	JUN 4
1969	69.4	09:10 MST, JUN 26	64.3	JUN 26

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 12 cont'd) BELLY RIVER NEAR MOUNTAIN VIEW - STATION NO. 05AD005

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1970	102	15:28 MST, JUN 13	85.2	JUN 14
1971	54.1	07:00 MST, MAY 28	53.5	MAY 28
1972	76.7	06:00 MST, JUN 2	73.6	JUN 2
1973	45.0	16:30 MST, JUN 9	43.6	MAY 19
1974	71.1	03:30 MST, JUN 19	69.9	JUN 18
1975	416	01:50 MST, JUN 20	331	JUN 20**
1976	49.0	12:00 MST, MAY 11	47.9	MAY 11
1977	18.2	06:50 MST, JUN 9	17.8	JUN 9
1978	48.1	16:55 MST, JUN 6	46.7	JUN 6
1979	56.6	10:30 MST, MAY 27	55.1	MAY 27
1980	74.7	14:20 MST, MAY 26	70.5	MAY 26
1981	65.6	21:50 MST, MAY 22	62.9	MAY 22
1982	45.1	09:25 MST, JUN 16	44.6	JUN 16

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 13

OLDMAN RIVER NEAR LETHBRIDGE - STATION NO. 05AD007

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1912			419	JUN 17
1913			705	MAY 29
1914			348	JUN 5
1915			626	JUN 27
1916			1220	JUN 20
1917			1120	JUN 10
1918			569	JUN 15
1919			547	MAY 30
1920			501	JUN 19
1921			510	MAY 26
1922			597	JUN 7
1923	2830	16:30 MST, JUN 2	2360	JUN 2
1924			490	JUN 8
1925			547	MAY 24
1926	244	08:30 MST, JUN 21	241	JUN 21
1927	1420	16:30 MST, JUN 12	1380	JUN 12
1928	1240	17:30 MST, JUL 2	1200	JUL 2
1929	1180	18:00 MST, JUN 4	1110	JUN 4
1930			402	JUN 1
1931			250	MAY 18
1932			852	JUN 3
1933			445	JUN 18
1934			991	JUN 8
1935			385	MAY 25
1936			292	JUN 3
1937			1130	JUN 14
1938			804	MAY 28
1939			371	JUN 18

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 13 cont'd) OLDMAN RIVER NEAR LETHBRIDGE - STATION NO. 05AD007

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1940			268	MAY 14
1941			181	JUN 4
1942	2710	12:00 MST, JUN 7	2340	JUN 7
1943			549	JUN 20
1944			166	JUN 29
1945			813	JUN 8
1946			484	MAY 30
1947			643	MAR 17
1948			2830	JUN 18
1953	3110	02:00 MST, JUN 10*	2890	JUN 10**
1958	439	01:00 MST, MAY 14	416	MAY 14
1959	612	06:00 MST, JUN 7	606	JUN 7
1960			379	JUN 5
1961	586	09:00 MST, MAY 29	572	MAY 29
1962			259	JUN 15
1963			861	JUL 1
1964	2090	13:00 MST, JUN 10	1980	JUN 10
1965	968	12:00 MST, JUN 19	923	JUN 19
1966	699	03:00 MST, JUN 6	682	JUN 6
1967	1090	06:00 MST, JUN 2	1060	JUN 1
1968	413	08:00 MST, JUN 9	408	JUN 9
1969	974	10:27 MST, JUN 30	957	JUN 30
1970			722	JUN 16
1971	586	13:00 MST, JUN 1	583	JUN 1
1972	892	08:40 MST, JUN 2	867	JUN 2
1973	257	00:04 MST, MAY 21	250	MAY 21
1974	711	08:25 MST, JUN 19	697	JUN 19
1975	2820	20:00 MST, JUN 21	2440	JUN 21
1976			365	MAY 15
1977	58.0	03:00 MST, MAY 13	57.5	MAY 13
1978	467	22:40 MST, JUN 10	459	JUN 10
1979	532	08:40 MST, MAY 28	522	MAY 28
1980	843	MAY 27	807	MAY 27
1981	1170	13:00 MST, MAY 23	1100	MAY 24
1982	348	17:25 MST, JUN 18	325	JUN 17

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

TABLE 14

WATERTON RIVER NEAR STAND OFF - STATION NO. 05AD008

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1916			297	JUN 22
1917			144	JUN 11
1918			122	JUN 13
1919			116	MAY 28
1920			133	JUN 17
1921			136	JUN 9
1922			175	JUN 5
1923			309	JUN 2
1924			164	JUN 16
1925			163	MAY 22
1926			64.6	OCT 19
1927			263	JUN 10
1928			283	JUL 2
1929			161	MAY 25
1930			95.1	MAY 22
1935			102	MAY 25
1936			122	MAY 16
1937			360	JUN 13
1938			145	MAY 26
1939			67.4	MAY 20
1940			67.4	MAY 27
1941			55.8	JUN 2
1942			447	JUN 6
1943			139	MAY 31
1944			73.6	JUN 17
1945			190	JUN 7
1946			120	MAY 28
1947			117	MAY 10
1948			317	JUN 17
1949			117	MAY 31

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 14 cont'd) WATERTON RIVER NEAR STAND OFF - STATION NO. 05AD008

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1950			189	JUN 21
1951			294	JUN 25
1952			108	MAY 21
1953			382	JUN 4
1954			202	MAY 22
1955			178	MAY 19
1956			180	MAY 23
1957			168	MAY 21
1958			139	MAY 27
1959			171	JUN 7
1960			120	JUN 4
1961			203	MAY 27
1962			121	JUN 16
1963			160	JUN 12
1964			467	JUN 10**
1965			266	JUN 26
1966			202	JUN 5

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 15

DRYWOOD CREEK NEAR THE MOUTH - STATION NO. 05AD010

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1920			11.9	MAY 18
1921			25.5	MAY 23
1922			31.7	JUN 6
1923			94.3	JUN 1
1924			39.9	JUN 7
1925			17.2	JUN 14
1926			14.3	SEP 9
1927			47.3	JUN 11
1928			30.6	JUL 1
1929			21.8	MAY 26
1930			17.0	MAY 4
1967	54.9	21:30 MST, MAY 17	48.7	MAY 22
1969	70.8	15:11 MST, JUN 26	61.4	JUN 26
1970			41.6	JUN 14
1971	26.2	05:30 MST, MAY 28	24.7	MAY 31
1972	34.8	03:40 MST, JUN 1	32.8	JUN 1
1973	17.4	06:00 MST, MAY 19	16.4	MAY 19
1974	26.3	06:50 MST, JUN 13	25.1	JUN 13
1975	286	03:30 MST, JUN 20*	181	JUN 20**
1976	19.1	16:15 MST, MAY 11	18.0	MAY 11
1977	4.8	00:00 MST, MAY 12	4.4	MAY 12
1978	22.8	09:10 MST, JUN 6	21.6	JUN 6
1979	22.6	08:45 MST, MAY 27	21.1	MAY 27
1980	61.7	11:50 MST, MAY 26	49.6	MAY 26
1981	82.3	09:10 MST, MAY 22	68.7	MAY 22
1982	15.8	15:15 MST, JUN 5	15.3	JUN 5

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 16

OLDMAN RIVER NEAR MONARCH - STATION NO. 05AD019

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1949			182	MAY 25
1950			257	JUN 16
1951			527	JUN 25
1952			216	APR 28
1953			1550	JUN 10**
1954			464	MAY 20
1955			396	MAY 21
1956			419	MAY 22
1957			247	MAY 22
1958			273	MAY 13
1959			297	MAY 27
1960			274	MAY 14
1961			462	MAY 28
1962			207	JUN 15
1963			725	JUL 1
1964			623	JUN 9
1965			595	JUN 19
1966			309	JUN 6
1967			714	JUN 1
1968			270	MAY 24
1969			569	JUN 27

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 17

WATERTON RIVER NEAR GLENWOOD - STATION NO. 05AD028

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1967	248	01:00 MST, JUN 5	205	JUN 5
1968	144	14:51 MST, JUN 8	132	JUN 8
1969	254	20:30 MST, JUN 28	232	JUN 29
1970	283	15:10 MST, JUN 15	270	JUN 15
1971	150	05:30 MST, MAY 30	148	MAY 31
1972	221	05:50 MST, JUN 3	209	JUN 3
1973	58.3	20:30 MST, MAY 22	58.3	MAY 22
1974	218	00:40 MST, JUN 19	212	JUN 19
1975	762	21:30 MST, JUN 20*	660	JUN 20**
1976	111	13:20 MST, MAY 15	111	MAY 15
1977			7.9	MAY 2
1978	132	17:05 MST, JUN 10	131	JUN 10
1979	169	18:25 MST, MAY 28	143	MAY 29
1980	253	04:20 MST, MAY 26	243	MAY 26
1981	279	17:50 MST, MAY 22	261	MAY 23
1982	169	23:00 MST, JUN 17	137	JUN 18

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 18

LEE CREEK AT CARDSTON - STATION NO. 05AE002

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1910			3.9	MAY 19
1911			39.6	MAY 15
1913			18.5	APR 8
1914			6.3	MAR 29
1921			9.0	APR 2
1922			10.0	APR 29
1923			22.0	JUN 22
1924			26.5	JUN 7
1925			8.6	MAY 3
1926			3.5	JUN 21
1927			81.8	MAY 31
1928			29.7	JUL 1
1929			15.5	JUN 3
1930			10.7	MAY 4
1931			1.8	MAY 30
1932			6.8	MAY 21
1933			7.1	MAY 14
1934			28.6	JUN 7
1935			14.2	JAN 25
1936			17.8	MAR 2
1937			57.2	JUN 13
1938			11.0	MAY 2
1939			4.0	MAR 21
1940			8.9	MAR 16
1941			4.9	JUN 2
1942			44.2	JUN 5
1943			9.9	JUN 9
1944			6.1	JUN 27
1945			22.2	JUN 6
1946			3.9	MAY 28
1947			14.8	MAY 3
1948			130	JUN 17
1949			13.8	MAY 22

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 18 cont'd) LEE CREEK AT CARDSTON - STATION NO. 05AE002

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1950			13.2	MAY 13
1951	221	17:00 MST, JUN 24	110	JUN 24
1952			12.4	MAR 27
1953	170	24:00 MST, JUN 3	96.8	JUN 4
1954			20.3	MAY 19
1955			46.4	MAY 18
1956			11.8	JUL 4
1957	16.1	08:00 MST, MAY 14	12.5	MAY 14
1958	15.5	07:00 MST, JUN 10	11.7	JUN 10
1959	17.0	01:00 MST, MAY 19	13.5	MAY 19
1960	10.6	05:00 MST, MAY 13	9.2	MAY 13
1961	10.1	04:00 MST, MAY 31	7.3	MAY 31
1962	10.3	17:00 MST, JUN 14	8.9	JUN 14
1963	12.3	13:00 MST, JUN 10	8.3	JUN 10
1964	323	17:00 MST, JUN 8*	151	JUN 8**
1965	36.0	13:00 MST, JUN 17	22.5	JUN 17
1966	68.5	19:00 MST, JUN 4	45.9	JUN 4
1967	47.3	07:30 MST, JUN 9	34.8	JUN 9
1968	13.3	03:20 MST, MAY 23	10.0	SEP 25
1969	53.2	09:25 MST, JUN 26	38.2	JUN 26
1970	54.1	18:20 MST, JUN 13	27.4	JUN 13
1971	13.8	13:00 MST, MAY 6	11.5	MAY 6
1972	24.1	17:10 MST, MAR 10	17.7	MAY 26
1973	7.1	06:00 MST, MAY 18	6.3	MAY 18
1974	15.3	22:10 MST, APR 30	12.1	MAY 1
1975	226	03:00 MST, JUN 20	146	JUN 20
1976	12.7	00:00 MST, MAR 18	8.2	MAY 6
1977	2.2	20:30 MST, APR 6	2.0	APR 9
1978	22.3	01:30 MST, JUN 1	13.8	JUN 1
1979	11.6	02:25 MST, MAY 17	10.1	MAY 16
1980	58.3	15:10 MST, MAY 26	46.6	MAY 26
1981	144	18:30 MST, MAY 22	62.4	MAY 22
1982			10.0	APR 13

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

TABLE 19

ST. MARY RIVER NEAR LETHBRIDGE - STATION NO. 05AE006

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1912			98.3	JUL 27
1913			168	JUN 3
1914			67.1	MAY 24
1915			162	JUL 29
1916			254	JUN 22
1917			163	JUN 13
1918	146	10:00 MST, JUN 16	141	JUN 16
1919			101	MAY 31
1920	118	11:00 MST, JUN 19	112	JUN 19
1921	113	00:30 MST, JUN 9	109	JUN 9
1922	128	12:00 MST, JUN 8	126	JUN 8
1923			101	JUN 22
1924	105	12:00 MST, JUN 8	91.5	JUN 9
1925	118	16:00 MST, MAY 24	116	MAY 25
1926			51.0	OCT 20
1927	300	03:30 MST, MAY 30	261	MAY 30
1928	218	06:00 MST, JUL 2	206	JUL 2
1929	175	21:45 MST, JUN 1	109	JUN 4
1930	82.7	11:30 MST, MAY 5	80.1	MAY 5
1931	46.7	MAY 18	42.8	MAY 19
1932	224	09:00 MST, MAY 22	139	MAY 22
1933	118	08:00 MST, JUN 10	112	JUN 7
1934	159	12:00 MST, JUN 9	156	JUN 9
1935			75.6	MAY 26
1936	71.4	01:00 MST, APR 12	57.5	JUN 6
1937	238	01:30 MST, JUN 14	196	JUN 14
1938	140	18:30 MST, MAY 29	136	MAY 29
1939	42.2	18:00 MST, MAY 25	38.2	MAY 26

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 19 cont'd) ST. MARY RIVER NEAR LETHBRIDGE - STATION NO. 05AE006

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1940	36.8	11:30 MST, MAY 22	34.5	MAY 22
1941	27.2	16:00 MST, JUN 5	26.7	JUN 5
1942	175	23:00 MST, JUN 6	165	JUN 7
1943	138	22:00 MST, JUN 21	136	JUN 21
1944	21.3	09:00 MST, JUN 29	18.9	JUN 29
1945	125	09:00 MST, JUN 8	123	JUN 8
1946	68.8	19:30 MST, JUN 7	62.9	JUN 8
1947	96.6	06:00 MST, MAR 20	87.2	MAR 20
1948	416	08:30 MST, JUN 18	362	JUN 18
1949	59.7	17:00 MST, JUN 1	59.2	JUN 1
1950	137	09:00 MST, JUN 26	133	JUN 26
1951	167	08:30 MST, JUN 25	136	JUN 25
1952	68.8	06:30 MST, JUN 16	67.4	JUN 15
1953	442	12:00 MST, JUN 4	408	JUN 4
1954	199	13:00 MST, MAY 21	175	MAY 22
1955	108	JUN 28	104	JUL 4
1956	113	08:00 MST, JUN 1	113	JUN 1
1957	83.0	20:00 MST, MAY 23	81.6	MAY 23
1958	94.0	17:00 MST, JUN 12	88.6	JUN 13
1959	114	03:00 MST, JUN 11	113	JUN 11
1960			40.5	MAY 21
1961	5.4	14:00 MST, JUN 19	2.8	JUN 6
1962	31.7	13:00 MST, MAR 19	26.9	MAR 19
1963	106	03:00 MST, JUL 1	86.1	JUL 1
1964	459	04:00 MST, JUN 11	447	JUN 11
1965	123	10:00 MST, JUN 27	122	JUN 27
1966	119	19:00 MST, JUN 6	118	JUN 7
1967			185	MAY 26
1968			86.9	SEP 26
1969			163	JUN 30

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 19 cont'd) ST. MARY RIVER NEAR LETHBRIDGE - STATION NO. 05AE006

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1970	150	14:33 MST, JUN 16	147	JUN 16
1971			166	JUN 1
1972	141	06:40 MST, JUN 10	131	JUN 13
1973	26.9	00:30 MST, JUN 22	26.3	JUN 21
1974	90.9	11:20 MST, JUN 22	90.0	JUN 22
1975	731	21:50 MST, JUN 20*	702	JUN 21**
1976	53.0	06:40 MST, MAY 20	52.1	MAY 20
1977	12.0	11:10 MST, FEB 27	6.2	FEB 21
1978	95.4	15:35 MST, JUN 13	94.9	JUN 13
1979	116	16:35 MST, MAY 30	116	MAY 30
1980	266	02:35 MST, MAY 27	242	MAY 27
1981			225	MAY 25
1982	72.8	10:30 MST, JUN 10	69.8	JUN 9

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 20

ST. MARY RIVER AT INTERNATIONAL BOUNDARY - STATION NO. 05AE027

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1903			175	JUN 8
1904			110	JUN 7
1905			92.6	JUN 7
1906			75.3	JUN 5
1907			159	JUN 23
1908	1130	JUN 5*	793	JUN 5**
1909			186	JUN 4
1910			83.8	MAY 27
1911			110	JUN 13
1912			98.5	MAY 21
1913			152	JUN 2
1914			88.3	JUN 4
1915	83.0	JUN 26	75.6	JUN 26
1916	253	JUN 22	244	JUN 22
1917			147	JUN 11
1918	147	JUN 14	141	JUN 14
1919	124	MAY 30	122	MAY 30
1920	130	11:00 MST, JUN 18	126	JUN 18
1921	150	15:00 MST, MAY 26	139	MAY 26
1922	149	09:30 MST, JUN 7	149	JUN 7
1923	99.4	11:00 MST, JUN 11	97.4	JUN 11
1924	85.8	11:30 MST, JUN 17	84.4	JUN 17
1925	141	22:00 MST, MAY 23	135	MAY 24
1926			46.2	OCT 20
1927	220	16:00 MST, JUN 11	212	JUN 11
1928	151	17:00 MST, MAY 27	149	MAY 27
1929	106	16:30 MST, MAY 25	102	MAY 26

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 20 cont'd) ST. MARY RIVER AT INTERNATIONAL BOUNDARY
- STATION NO. 05AE027

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1930	89.5	20:00 MST, JUN 12	86.4	JUN 12
1931	69.1	07:00 MST, MAY 18	66.3	MAY 18
1932			86.1	JUN 18
1933	118	19:00 MST, JUN 9	117	JUN 6
1934	140	22:00 MST, JUN 8	136	JUN 8
1935	86.7	17:30 MST, MAY 24	84.7	MAY 25
1936	83.5	10:30 MST, JUN 3	82.1	JUN 3
1937	162	18:45 MST, JUN 13	156	JUN 14
1938	135	13:15 MST, MAY 28	133	MAY 29
1939	51.0	19:00 MST, MAY 24	44.2	MAY 25
1940	47.6	09:00 MST, MAY 21	45.0	MAY 21
1941	30.6	18:00 MST, JUN 29	27.6	JUN 29
1942	131	15:00 MST, JUN 8	129	JUN 8
1943	148	11:00 MST, JUN 20	144	JUN 20
1944	37.4	12:00 MST, JUN 27	36.0	MAY 20
1945	106	06:45 MST, JUN 6	105	JUN 6
1946	64.3	17:30 MST, MAY 29	62.9	MAY 29
1947	88.1	24:00 MST, MAY 11	86.4	MAY 11
1948	281	15:30 MST, JUN 17	238	JUN 17
1949	72.8	16:00 MST, MAY 14	62.3	MAY 31
1950	149	07:00 MST, JUN 25	145	JUN 25
1951	261	14:30 MST, JUN 24	198	JUN 24
1952	88.6	00:30 MST, OCT 5	81.6	JUN 12
1953	328	15:00 MST, JUN 3	266	JUN 4
1954	166	17:00 MST, MAY 22	162	MAY 22
1955	132	16:00 MST, JUN 25	129	JUN 26
1956	154	14:00 MST, MAY 24	151	MAY 24
1957	101	18:30 MST, MAY 8	98.3	MAY 8
1958	90.6	11:00 MST, JUN 12	89.5	JUN 12
1959	123	02:30 MST, JUN 8	121	JUN 7

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 20 cont'd) ST. MARY RIVER AT INTERNATIONAL BOUNDARY - STATION NO. 05AE027

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1960	83.5	22:00 MST, JUN 5	81.8	JUN 5
1961	103	22:30 MST, MAY 30	98.8	MAY 31
1962	55.5	20:00 MST, JUN 5	48.4	MAY 31
1963	90.6	24:00 MST, JUN 12	72.5	JUN 11
1964	595	16:30 MST, JUN 8	481	JUN 9
1965	148	15:00 MST, JUN 20	146	JUN 20
1966	148	18:00 MST, JUN 4	125	JUN 4
1967	167	19:00 MST, MAY 31	163	MAY 31
1968	71.4	19:15 MDT, JUN 7	67.7	JUN 7
1969	117	12:15 MDT, JUN 27	108	JUN 27
1970	182	16:00 MDT, JUN 13	165	JUN 14
1971	162	10:15 MST, MAY 31	158	MAY 31
1972	141	12:15 MST, JUN 12	138	JUN 12
1973	72.5	04:45 MST, JUN 10	70.5	JUN 10
1974	187	10:00 MST, JUN 19	180	JUN 19
1975	660	04:00 MST, JUN 21	470	JUN 21
1976	90.9	18:00 MST, MAY 13	87.2	MAY 14
1977	39.1	14:00 MDT, JUN 9	38.2	JUN 9
1978	116	10:00 MST, JUN 10	114	JUN 10
1979	144	12:30 MDT, JUN 10	140	MAY 28
1980	140	13:30 MDT, MAY 26	125	MAY 26
1981	107	22:00 MDT, MAY 22	99.4	MAY 23
1982	102	02:00 MDT, MAY 28	101.0	MAY 28

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

TABLE 21

SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT - STATION NO. 05AJ001

MAXIMUM ANNUAL DISCHARGES

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m³/s	TIME AND DATE	m³/s	DATE
1902	5660	AUG *		
1908	5240	AUG		
1911			1140	JUN 19
1912			1130	JUN 19
1913			974	JUN 4
1914			722	JUN 7
1915	2550	21:00 MST, JUN 28	2400	JUN 28
1916			2200	JUN 23
1917			1630	JUN 5
1918			1040	JUN 16
1919			991	JUN 1
1920			824	JUL 10
1921			912	MAY 29
1922			940	JUN 8
1923	4110	22:00 MST, JUN 3	3710	JUN 3
1924			821	JUN 17
1925			963	MAY 25
1926			682	SEP 14
1927	2140	17:00 MST, JUN 13	2090	JUN 13
1928	1840	13:00 MST, JUL 3	1830	JUL 3
1929	3450	22:00 MST, JUN 5	3060	JUN 5
1930			725	JUN 12
1931			524	JUN 22
1932	2940	JUN 5	2710	JUN 5
1933			940	JUN 20
1935			682	JUN 20
1936	694	JUN 5	688	JUN 5
1937	1370	JUN 16	1290	JUN 16
1938			1090	MAY 29
1939			960	JUN 19

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m³/s - cubic metres per second

(Table 21 cont'd) SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT
- STATION NO. 05AJ001

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1940			572	MAY 28
1941			391	JUN 6
1942	2650	10:30 MST, MAY 14	2080	MAY 14
1943			731	JUN 22
1944			317	JUN 17
1945	1050	08:00 MST, JUN 9	1030	JUN 8
1946			983	JUN 1
1947	1050	16:40 MST, MAY 13	1040	MAY 13
1948	2620	08:15 MST, JUN 20	2550	JUN 20
1949			575	JUN 4
1950			1090	JUN 25
1951	1780	00:20 MST, JUN 27	1680	SEP 2
1952			1070	JUN 15
1953	4300	08:30 MST, JUN 11	4080	JUN 11**
1954	1090	08:20 MST, MAY 22	1090	MAY 22
1955			991	MAY 22
1956			957	JUN 5
1957	739	21:00 MST, MAY 23	733	MAY 24
1958	651	16:10 MST, JUN 13	648	JUN 13
1959	917	10:00 MST, JUN 30	889	JUN 30
1960			580	MAY 16
1961			951	MAY 30
1962			379	JUN 19
1963	1970	22:00 MST, JUL 2	1550	JUL 3
1964	1950	18:00 MST, JUN 11	1830	JUN 11
1965	1640	17:00 MST, JUN 20	1520	JUN 21
1966	1150	17:00 MST, JUN 7	1130	JUN 7
1967	2360	04:00 MST, JUN 3	2170	JUN 3
1968			827	JUN 16
1969	2010	23:30 MST, JUL 1	1880	JUL 2

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* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

(Table 21 cont'd) SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT
- STATION NO. 05AJ001

	MAXIMUM INSTANTANEOUS		MAXIMUM DAILY	
YEAR	m^3/s	TIME AND DATE	m^3/s	DATE
1970	1440	04:40 MST, JUN 17	1360	JUN 17
1971	1270	09:30 MST, JUN 9	1240	JUN 9
1972	1370	13:00 MST, JUN 4	1350	JUN 4
1973	544	03:30 MST, MAY 30	521	MAY 30
1974	1320	09:30 MST, JUN 20	1290	JUN 20
1975	3170	01:00 MST, JUN 23	2860	JUN 23
1976	762	20:50 MST, AUG 8	731	AUG 11
1977	174	14:50 MST, JUN 14	169	JUN 14
1978	867	05:40 MST, JUN 12	855	JUN 12
1979	744	18:30 MST, MAY 30	734	MAY 30
1980	1110	16:35 MST, MAY 29	1080	MAY 29
1981	1720	02:30 MST, MAY 25	1690	MAY 25
1982	657	06:46 MST, JUN 20	635	JUN 20

---

* - Maximum Instantaneous Discharge
** - Maximum Daily Discharge
m^3/s - cubic metres per second

TABLE 22

DATES OF FIRST AND LAST ICE
FOR SELECTED HYDROMETRIC STATIONS IN THE OLDMAN RIVER BASIN

Station No.	Station Name	Dates of Last Ice			Dates of First Ice		
		Earliest	Mean	Latest	Earliest	Mean	Latest
05AA004	Pincher Creek at Pincher Creek	Mar. 5	Apr. 14	Apr. 28	N/A	N/A	N/A
05AA008	Crowsnest River at Frank	Jan. 16	Mar. 21	Apr. 20	Nov. 2	Nov. 16	Dec. 1
05AA022	Castle River near Beaver Mines	Feb. 29	Mar. 30	Apr. 25	Oct. 26	Nov. 13	Dec. 7
05AA023	Oldman River near Waldron's Corner	Mar. 18	Apr. 13	May 28	Oct. 9	Nov. 7	Nov. 27
05AA024	Oldman River near Brocket	Mar. 5	Apr. 2	Apr. 29	Oct. 31	Nov. 14	Dec. 5
05AA028	Castle River at Ranger Station	Mar. 9	Mar. 25	Apr. 24	N/A	N/A	N/A
05AB002	Willow Creek near Nolan	Mar. 1	Mar. 31	Apr. 23	Oct. 21	Nov. 3	Nov. 28
05AB007	Oldman River near Fort McLeod	Mar. 1	Mar. 25	Apr. 15	Oct. 14	Nov. 18	Jan. 1
05AB021	Willow Creek near Claresholm	Mar. 20	Apr. 1	Apr. 20	Nov. 2	Nov. 18	Dec. 3
05AD002	Belly River near Stand Off	Feb. 12	Mar. 31	Apr. 21	Oct. 10	Nov. 11	Dec. 3
05AD003	Waterton River near Waterton Park	Jan. 7	Mar. 4	May 3	Oct. 16	Nov. 30	Feb. 2
05AD005	Belly River near Mountain View	Jan. 13	Apr. 3	May 3	Oct. 13	Nov. 12	Dec. 22
05AD007	Oldman River near Lethbridge	Feb. 8	Mar. 23	Apr. 23	Oct. 15	Nov. 16	Jan. 1
05AD008	Waterton River near Stand Off	Mar. 9	Apr. 3	Apr. 20	Oct. 15	Nov. 11	Dec. 12
05AD010	Drywood Creek near the Mouth	Feb. 26	Mar. 27	Apr. 25	Oct. 25	Nov. 8	Nov. 20
05AD019	Oldman River near Monarch	Mar. 3	Mar. 30	Apr. 15	Oct. 16	Nov. 13	Jan. 1
05AD028	Waterton River near Glenwood	Feb. 23	Mar. 22	Apr. 30	Nov. 4	Nov. 20	Dec. 18
05AE002	Lee Creek at Cardston	Mar. 3	Mar. 31	Apr. 24	Oct. 20	Nov. 10	Dec. 16
05AE006	St. Mary River near Lethbridge	Feb. 13	Mar. 29	Apr. 26	Oct. 3	Nov. 12	Dec. 22
05AE027	St. Mary River at Int'l. Boundary	Feb. 8	Apr. 3	May 5	Oct. 18	Nov. 20	Dec. 29
05AJ001	South Saskatchewan River at Medicine Hat	Mar. 7	Apr. 3	Apr. 23	Oct. 15	Nov. 13	Dec. 5

NOTES

(1) The above data were obtained from the Surface Water Data reports, published by Water Survey of Canada. The data were selected from the "Ice Conditions" data up to December 1980.

(2) In the Water Survey of Canada reports "Ice Conditions" indicates the presence of ice at the gauging station whenever the ice has affected the stage-discharge relationship.

(3) Date of Last Ice - indicates the last date on which ice has affected the stage-discharge relationship.

(4) Date of First Ice - indicates the date on which ice first affected the stage-discharge relationship.

TABLE 23

MAXIMUM RECORDED FLOOD DISCHARGES FOR SELECTED STATIONS

Station No.	Stream and Station Location	Drainage Area km²	Period of Record	MAXIMUM RECORDED FLOODS Date	Peak Discharge m³/s
05AD005	Belly River near Mountain View (r since 1935)	319	1912-1982	June 4/53 June 8/64 June 20/75	127 464 * 416
05AD002	Belly River near Stand Off (r since 1935)	1,210	1913-1930 1949-1982	June 9/53 June 9/64 June 20/75	303 331 394 *
05AA022	Castle River near Beaver Mines	826	1945-1982	May 22/48 June 8/64 June 20/75	442 510 736 *
05AA008	Crowsnest River at Frank	402	1911-1919 1950-1982	June 9/53 May 19/54 May 20/56 May 27/61 June 18/65 May 31/72 June 19/75	73.9* 65.1 57.2 62.9 70.8 62.6 53.7
05AE002	Lee Creek at Cardston (r)	307	1910-1911 1912-1913 1920-1982	June 17/48 June 24/51 June 3/53 June 8/64 June 20/75	235 221 170 323 * 226
05AD007	Oldman River near Lethbridge (r) (since 1910)	17,000	1912-1948 1953 1958-1982	June 2/23 June 7/42 June 18/48 June 10/53 June 10/64 June 21/75	2,830 2,710 3,090 3,110 * 2,090 2,820
05AA004	Pincher Creek at Pincher Creek	155	1910-1930 1936 1966-1982	June 1/23 June 20/75 May 22/81	66.5 172 * 71.3
05AJ001	South Saskatchewan River at Medicine Hat (r)	56,400	1902,1908 1911-1933 1935-1982	Aug. /02 Aug. /08 June 3/23 June 5/29 June 11/53 June 23/75	5,660 * 5,240 4,110 3,450 4,300 3,170
05AE027	St. Mary River at International Boundary (r)	1,210	1903-1982	June 5/08 June 3/53 June 8/64 June 21/75	1,130 * 328 595 660
05AD003	Waterton River near Waterton Park	614	1908-1931 1948-1982	June 6/08 June 19/16 June 4/53 June 9/64 June 20/75	742 * 214 214 728 501
05AB021	Willow Creek near Claresholm (r) (since 1966)	1,160	1944-1982	June 24/51 June 9/53 June 29/63 July 1/69	121 283 * 255 105
05AB002	Willow Creek near Nolan (r) (since 1966))	2,290	1910-1923 1942-1982	June 26/15 June 2/23 May 12/42 May 23/48 June 9/53 May 19/55 June 30/63 June 30/69 June 21/75	120 230 552 107 592 * 107 368 120 101

* Maximum for period of record

r Discharge affected by significant upstream storage or diversion

TABLE 24

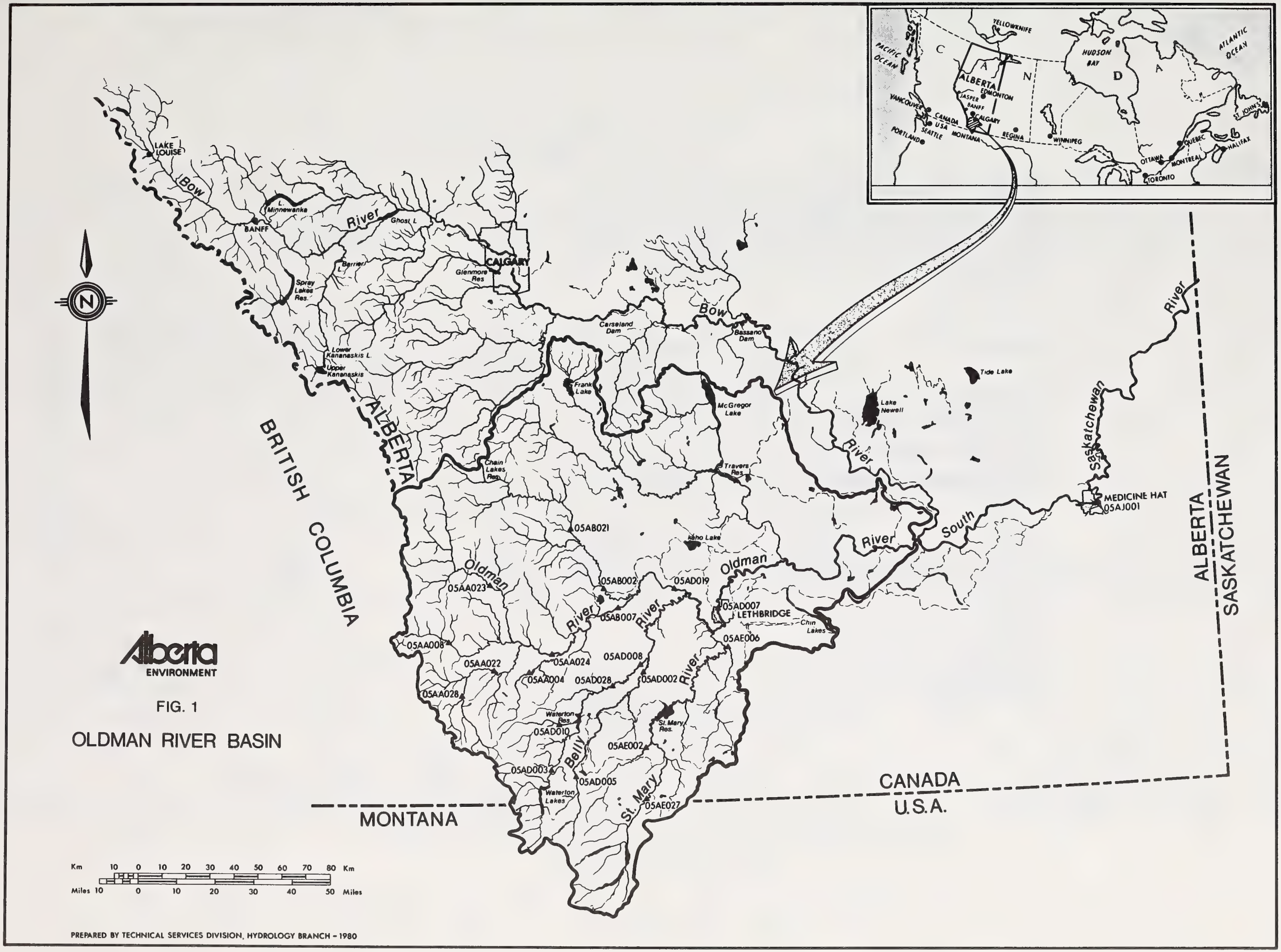
OLDMAN RIVER BASIN

AVERAGE RATIOS OF ANNUAL MAXIMUM INSTANTANEOUS PEAKS
TO ANNUAL MAXIMUM MEAN DAILY FLOWS

Station Number	Station Name	Peak to Mean Ratio
05AA004	Pincher Creek at Pincher Creek	1.42
05AA008	Crowsnest River at Frank	1.08
05AA022	Castle River near Beaver Mines	1.10
05AA023	Oldman River near Waldon's Corner	1.15
05AA024	Oldman River near Brocket	1.12
05AA028	Castle River at Ranger Station	1.10
05AB002	Willow Creek near Nolan	1.24*
05AB007	Oldman River near Fort MacLeod	--
05AB021	Willow Creek near Claresholm	1.16*
05AD002	Belly River near Stand Off	1.12
05AD003	Waterton River near Waterton Park	1.03
05AD005	Belly River near Mountain View	1.07
05AD007	Oldman River near Lethbridge	--**
05AD008	Waterton River near Stand Off	--
05AD010	Drywood Creek near the Mouth	1.13
05AD019	Oldman River near Monarch	--
05AD028	Waterton River near Glenwood	--
05AE002	Lee Creek at Cardston	1.43
05AE006	St. Mary River near Lethbridge	--**
05AE027	St. Mary River at International Boundary	1.06
05AJ001	South Saskatchewan River at Medicine Hat	--

NOTES: * Peak to mean ratio based solely on the period of record prior to regulation

** Peak to mean ratio not computed due to a high degree of upstream regulation



Alberta ENVIRONMENT

FIG. 1

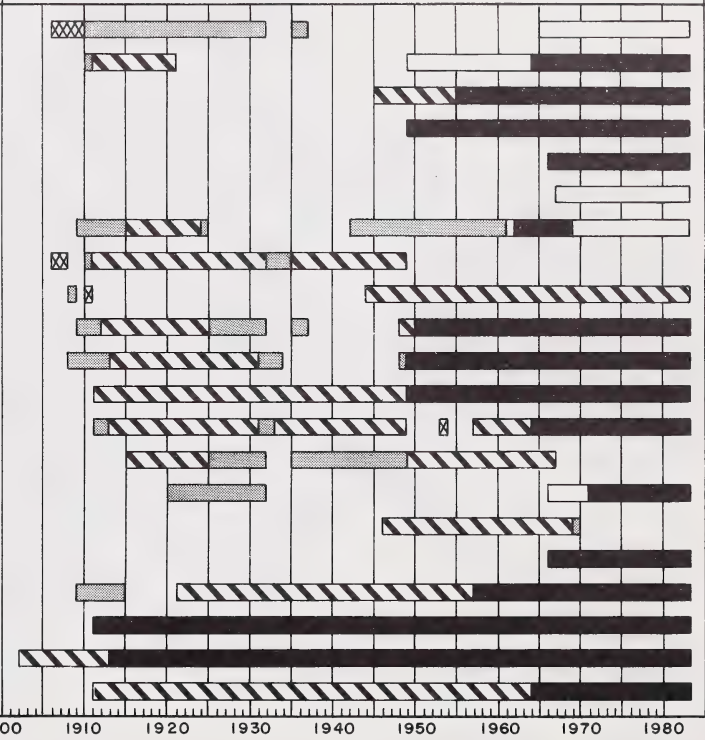
OLDMAN RIVER BASIN

PREPARED BY TECHNICAL SERVICES DIVISION, HYDROLOGY BRANCH - 1980

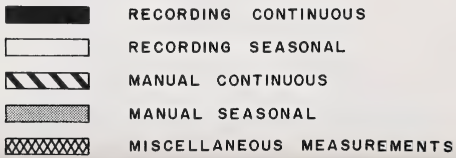
OLDMAN RIVER BASIN
SELECTED HYDROMETRIC GAUGING STATIONS **

STATION No.	STATION NAME		DRAINAGE AREA (Sq. km.)	REGULATED OR NATURAL FLOW
05AA004	PINCHER CREEK AT PINCHER CREEK	*	155	NATURAL
05AA008	CROWSNEST RIVER AT FRANK	*	401	NATURAL
05AA022	CASTLE RIVER NEAR BEAVER MINES	*	826	NATURAL
05AA023	OLDMAN RIVER NEAR WALDRON'S CORNER	*	1450	NATURAL
05AA024	OLDMAN RIVER NEAR BROCKET	*	4400	NATURAL
05AA028	CASTLE RIVER AT RANGER STATION		376	NATURAL
05AB002	WILLOW CREEK NEAR NOLAN		2290	REGULATED 1966
05AB007	OLDMAN RIVER NEAR FORT MacLEOD		5750	REGULATED
05AB021	WILLOW CREEK NEAR CLARESHOLM		1160	REGULATED 1966
05AD002	BELLY RIVER NEAR STAND OFF		1210	REGULATED 1935
05AD003	WATERTON RIVER NEAR WATERTON PARK	*	614	NATURAL
05AD005	BELLY RIVER NEAR MOUNTAIN VIEW	*	319	REGULATED 1935
05AD007	OLDMAN RIVER NEAR LETHBRIDGE	*	17000	REGULATED 1910
05AD008	WATERTON RIVER NEAR STAND OFF		1740	REGULATED 1966
05AD010	DRYWOOD CREEK NEAR THE MOUTH	*	238	NATURAL
05AD019	OLDMAN RIVER AT MONARCH		8880	REGULATED
05AD028	WATERTON RIVER NEAR GLENWOOD		1600	REGULATED 1966
05AE002	LEE CREEK AT CARDSTON	*	308	NATURAL
05AE006	ST. MARY RIVER NEAR LETHBRIDGE		3520	REGULATED 1911
05AE027	ST. MARY RIVER AT INTERNATIONAL BOUNDARY	*	1210	REGULATED
05AJ001	SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT	*	56500	REGULATED

YEARS OF RECORD (to December 1981)



LEGEND



* REAL TIME DATA AVAILABLE

** FROM SURFACE WATER DATA REFERENCE INDEX 1981 WATER SURVEY OF CANADA

FIG. 2

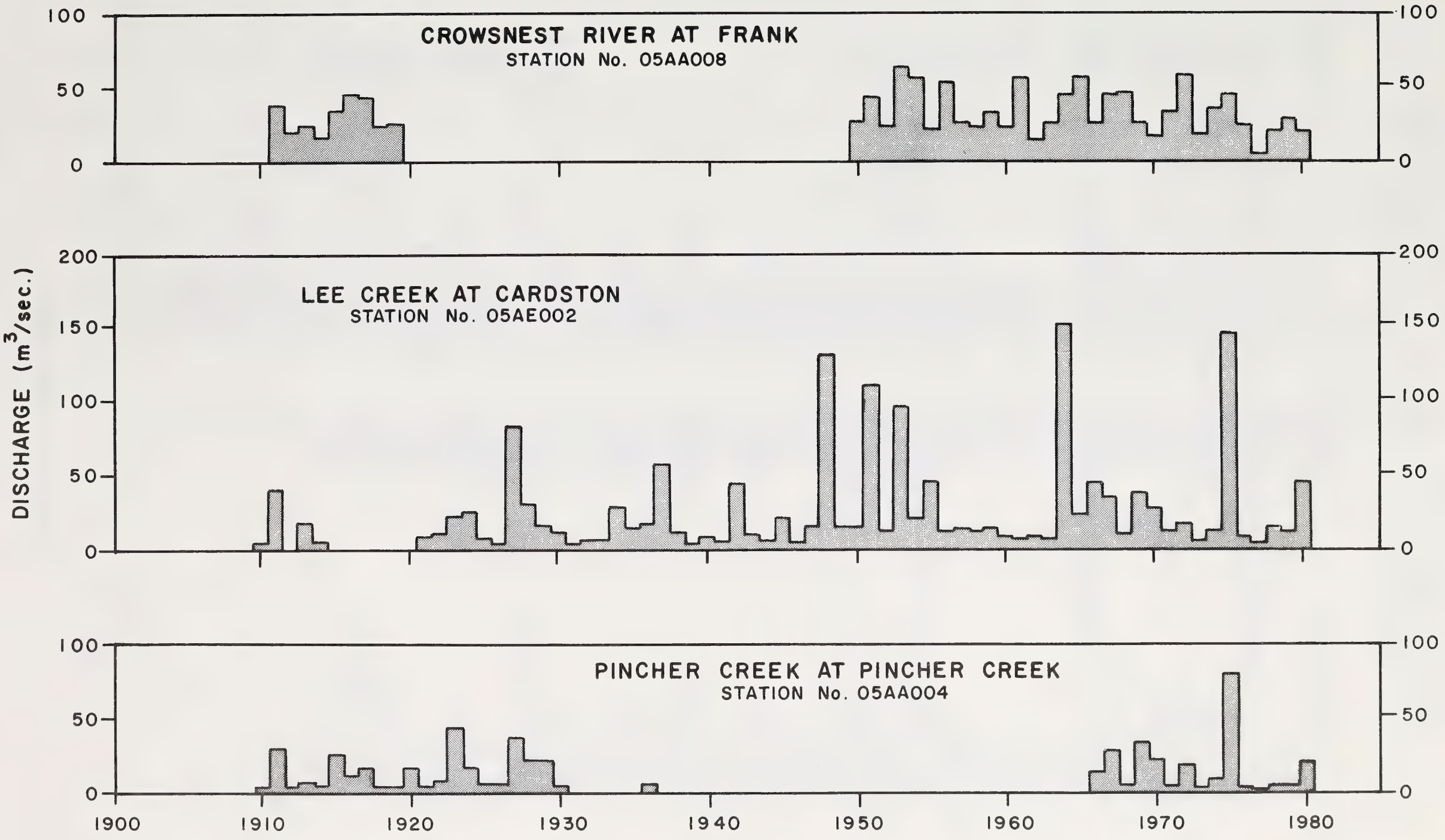


FIG. 3 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

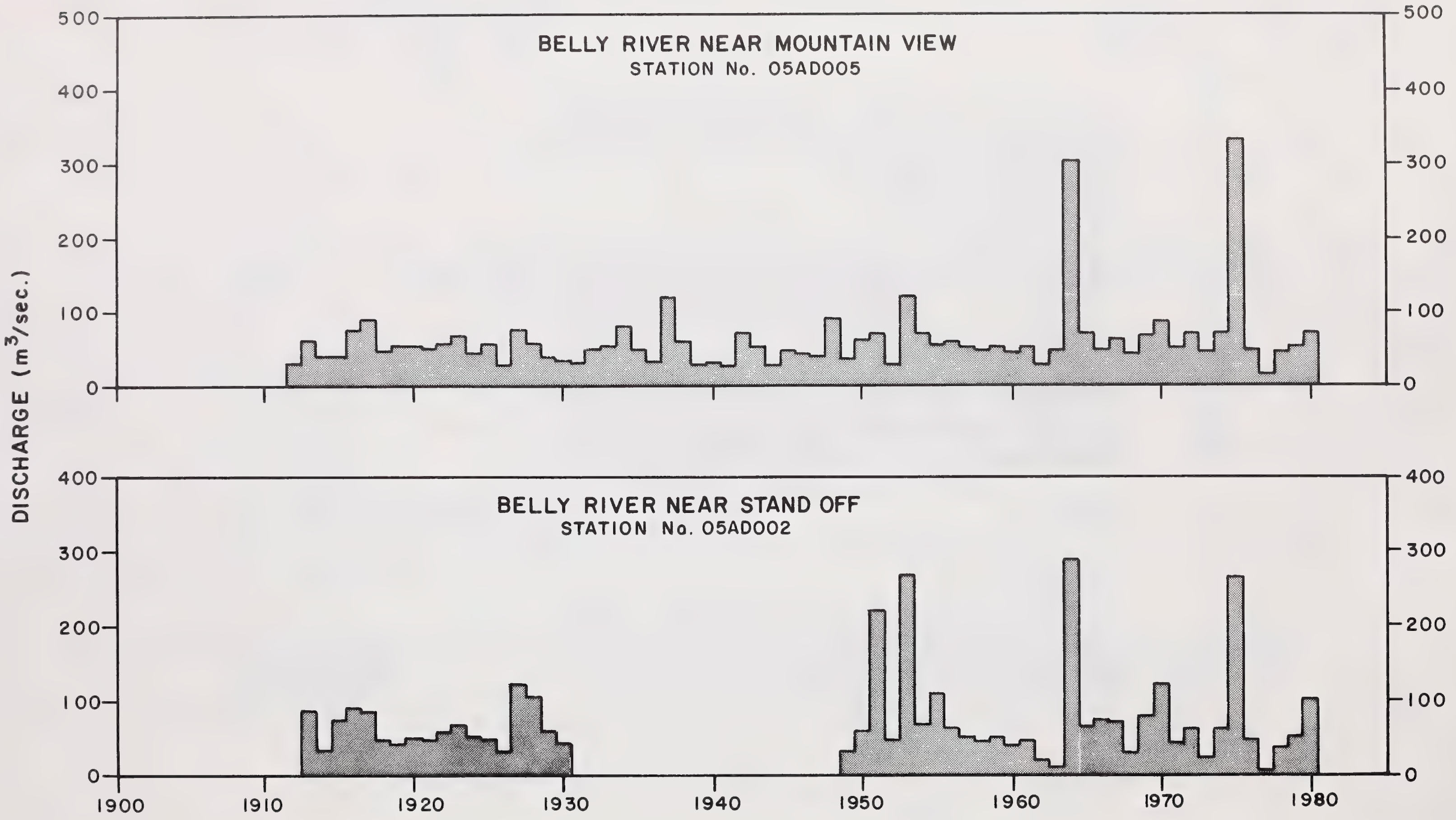


FIG. 4 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

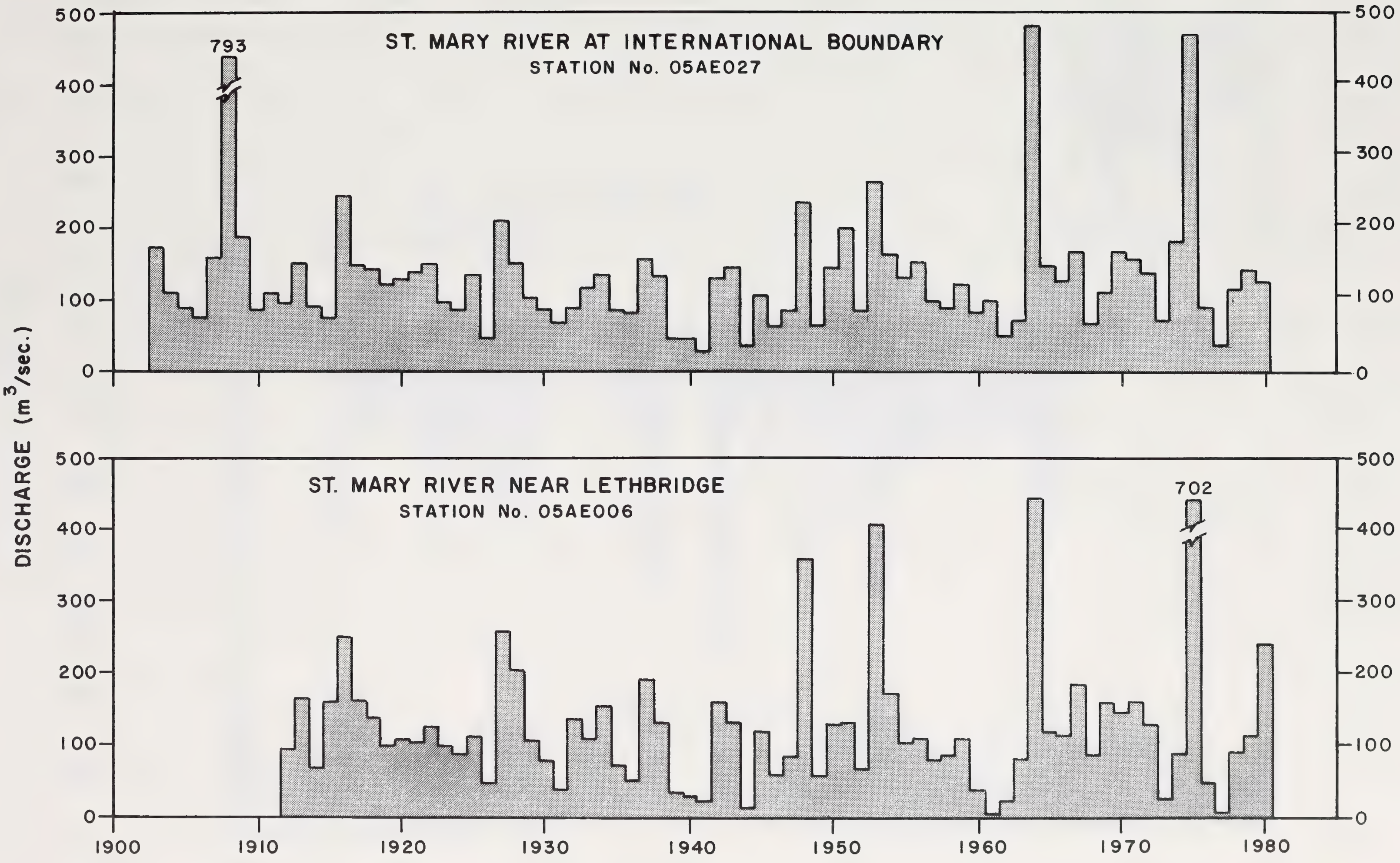


FIG. 5 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

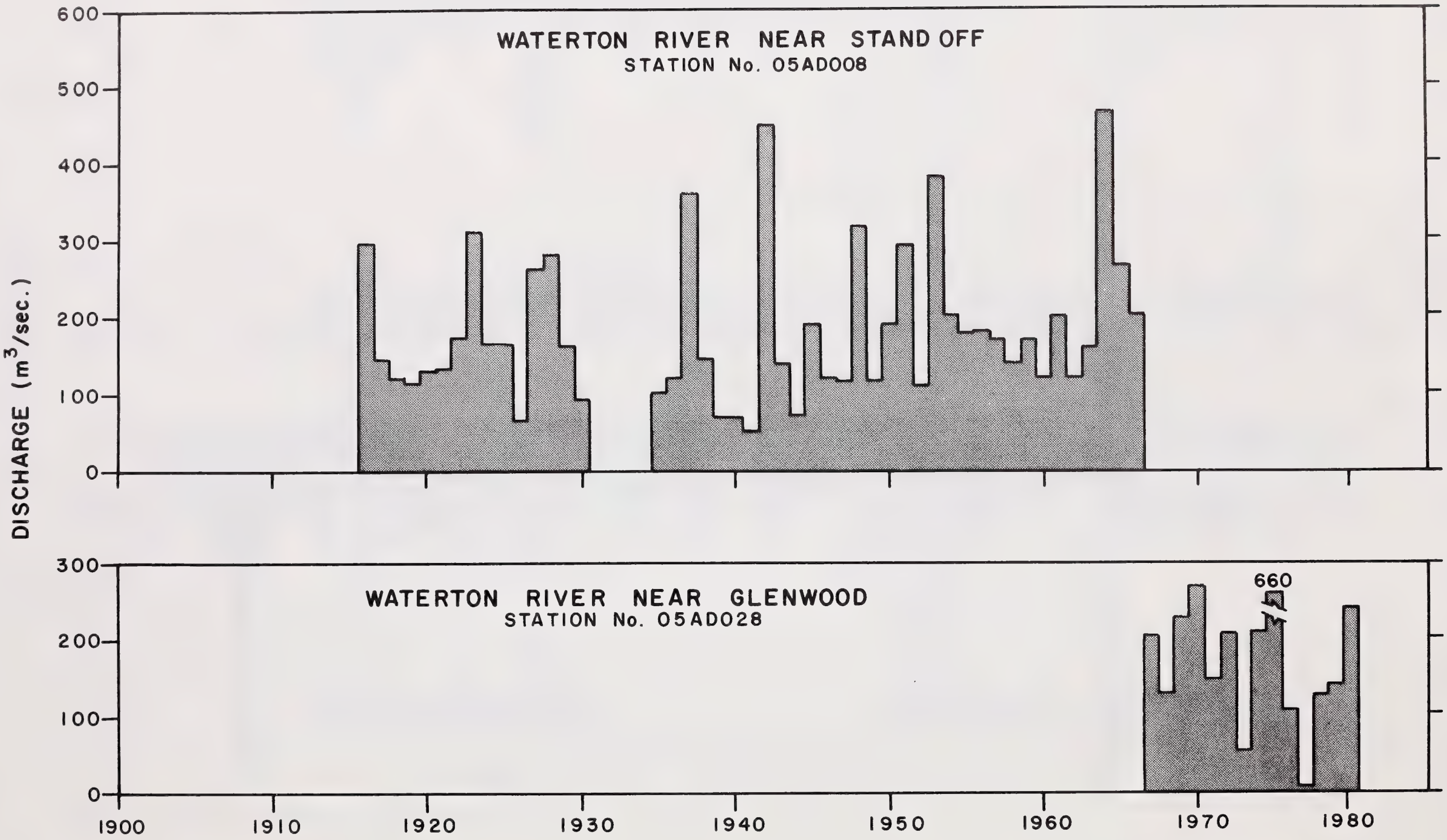


FIG. 6 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

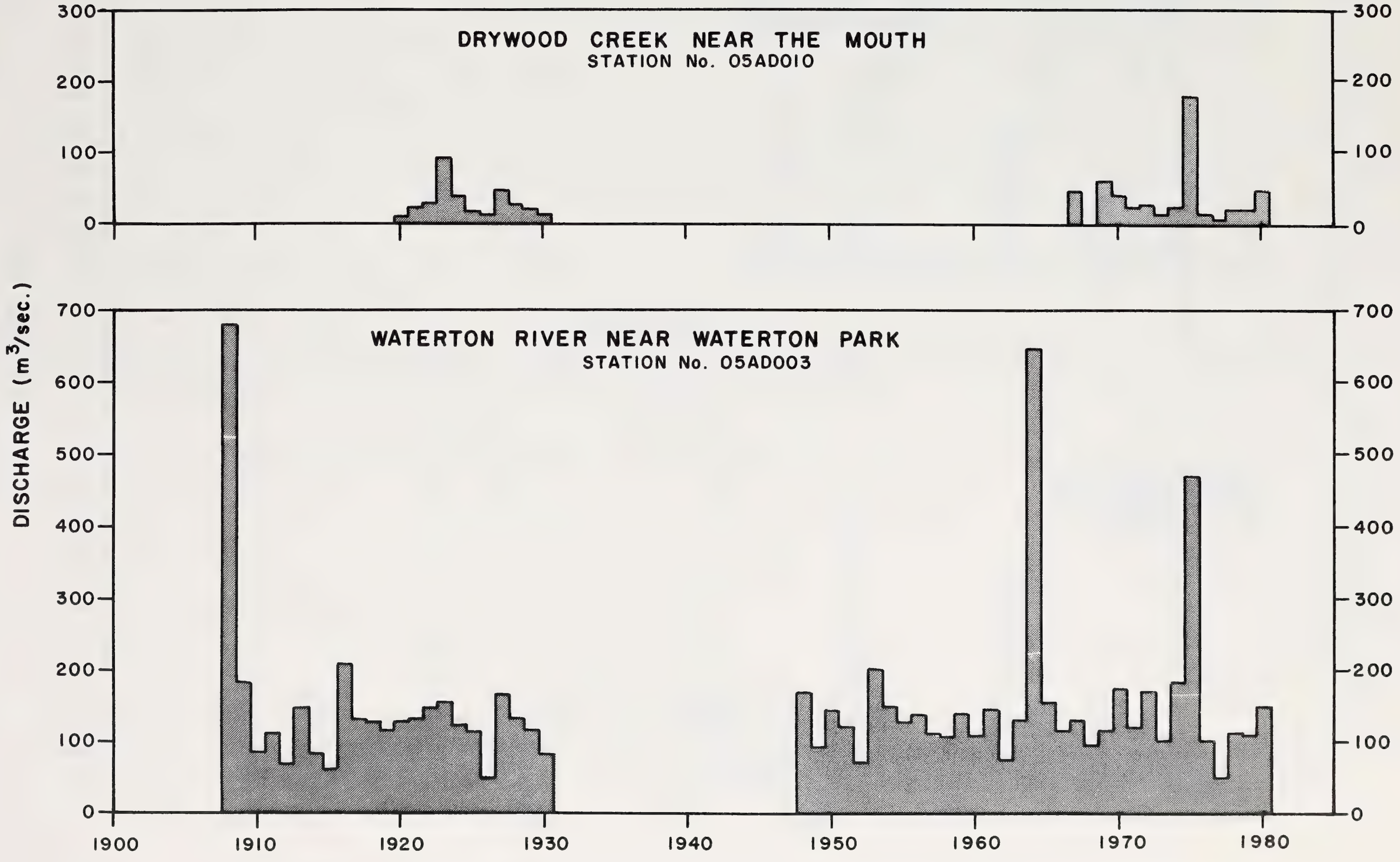


FIG. 7 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

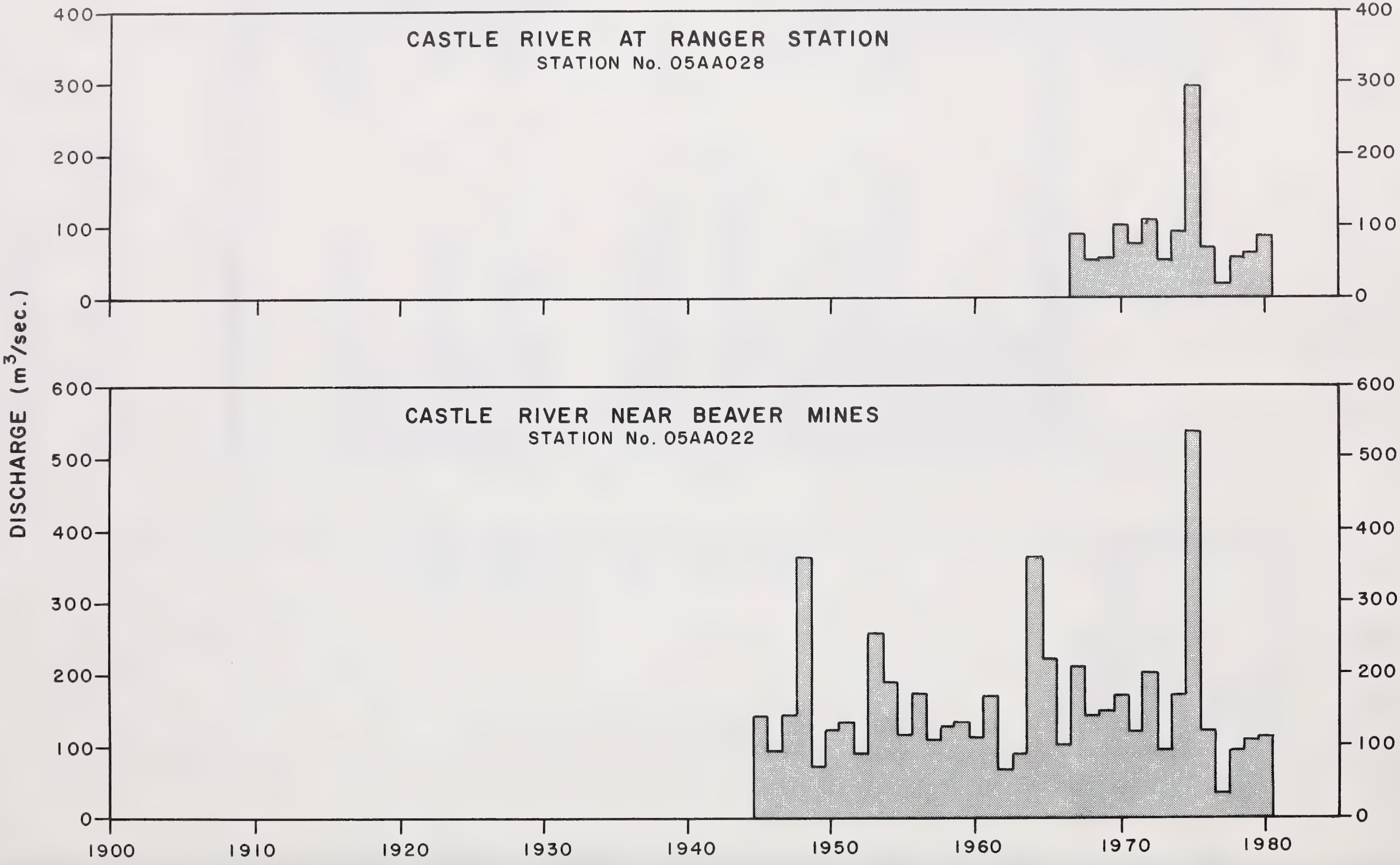


FIG. 8 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

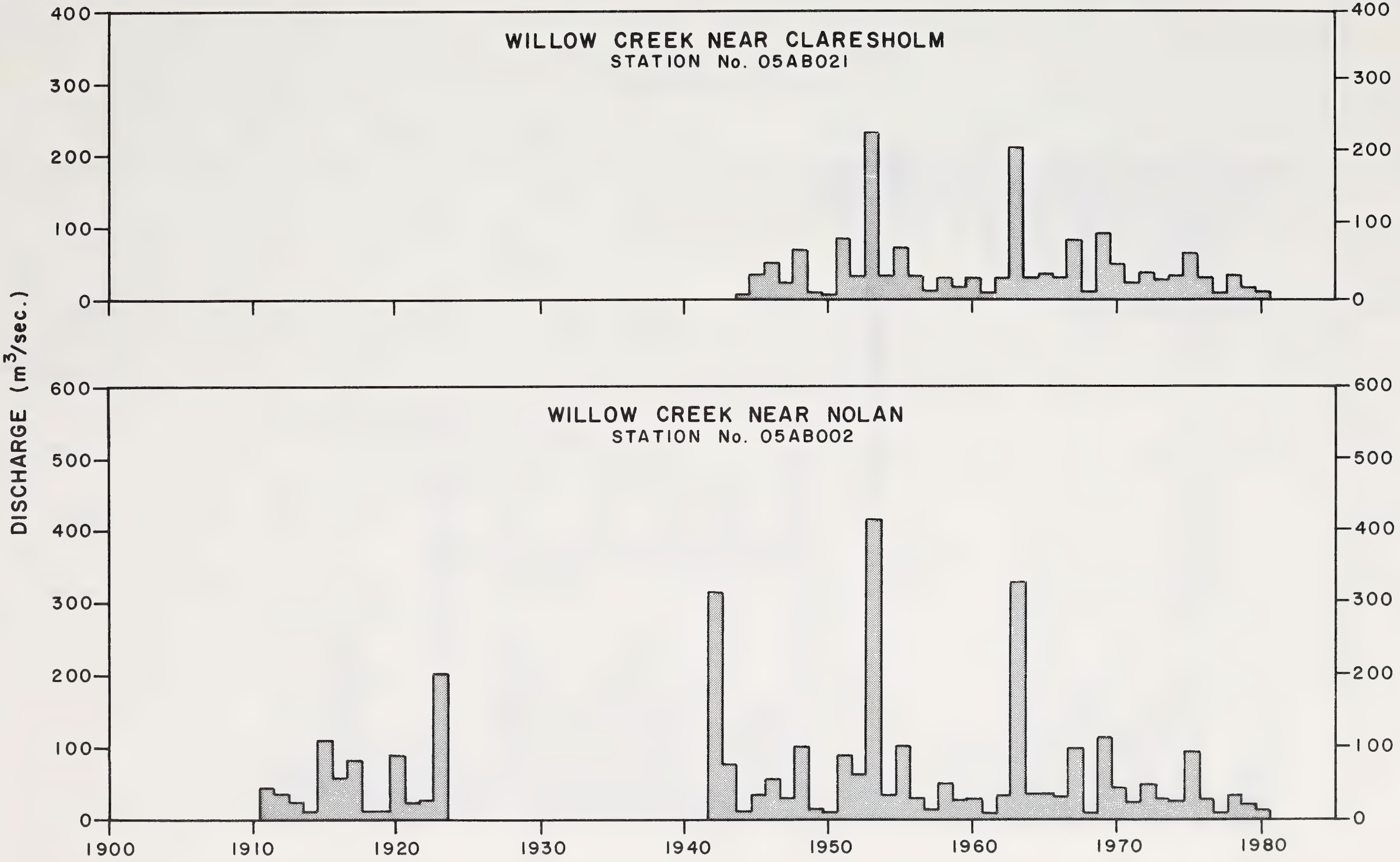


FIG. 9 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

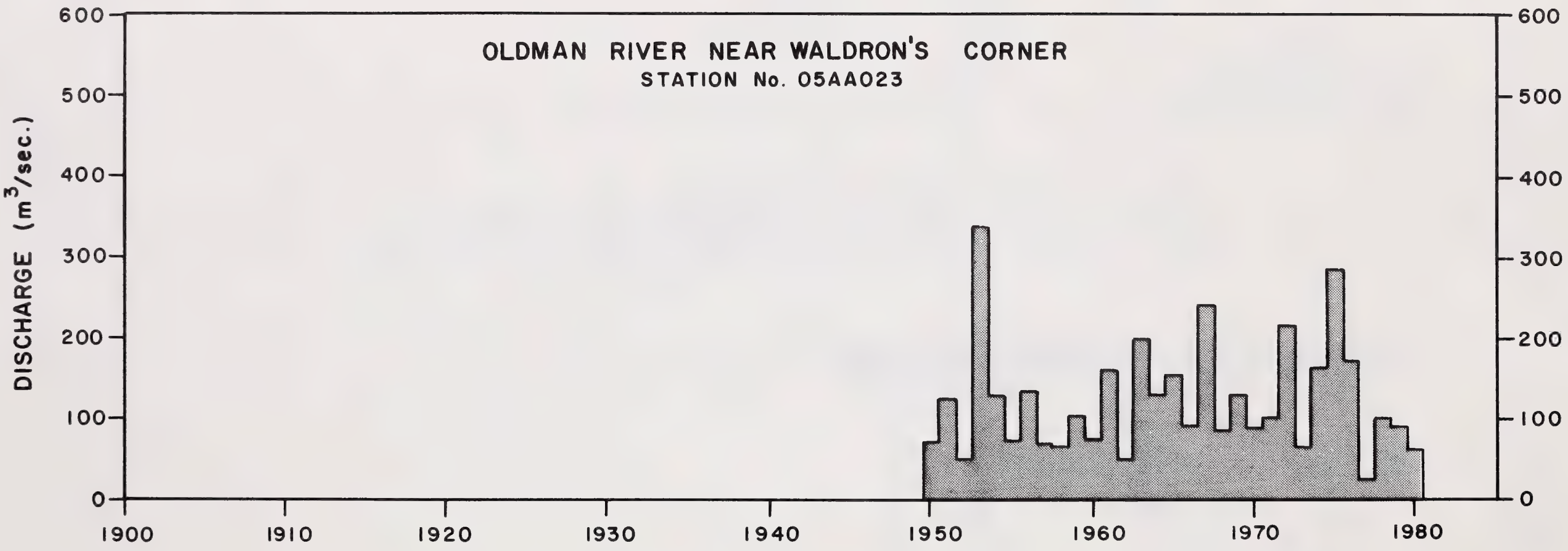


FIG. 10 HISTOGRAM OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

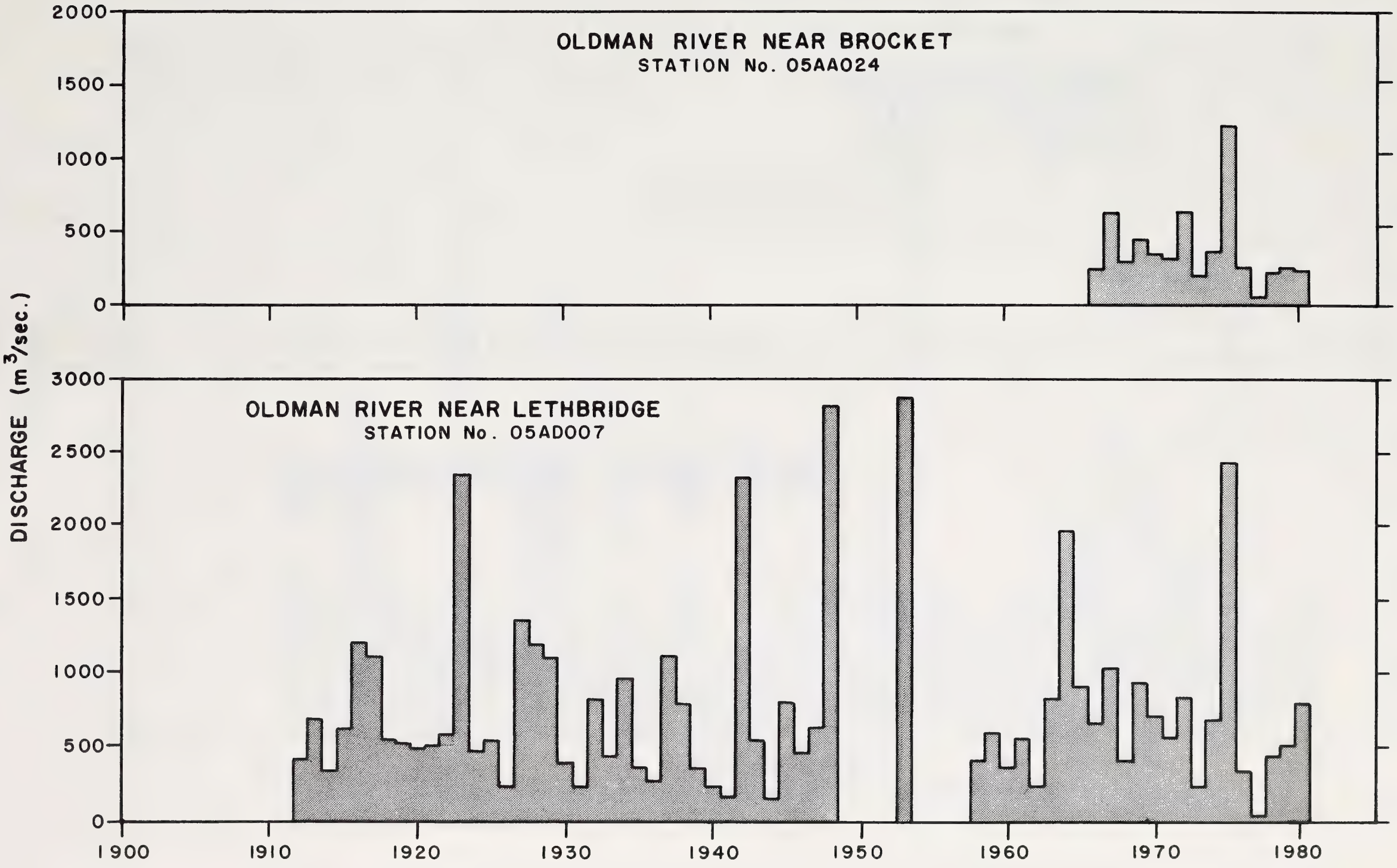


FIG. 11 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

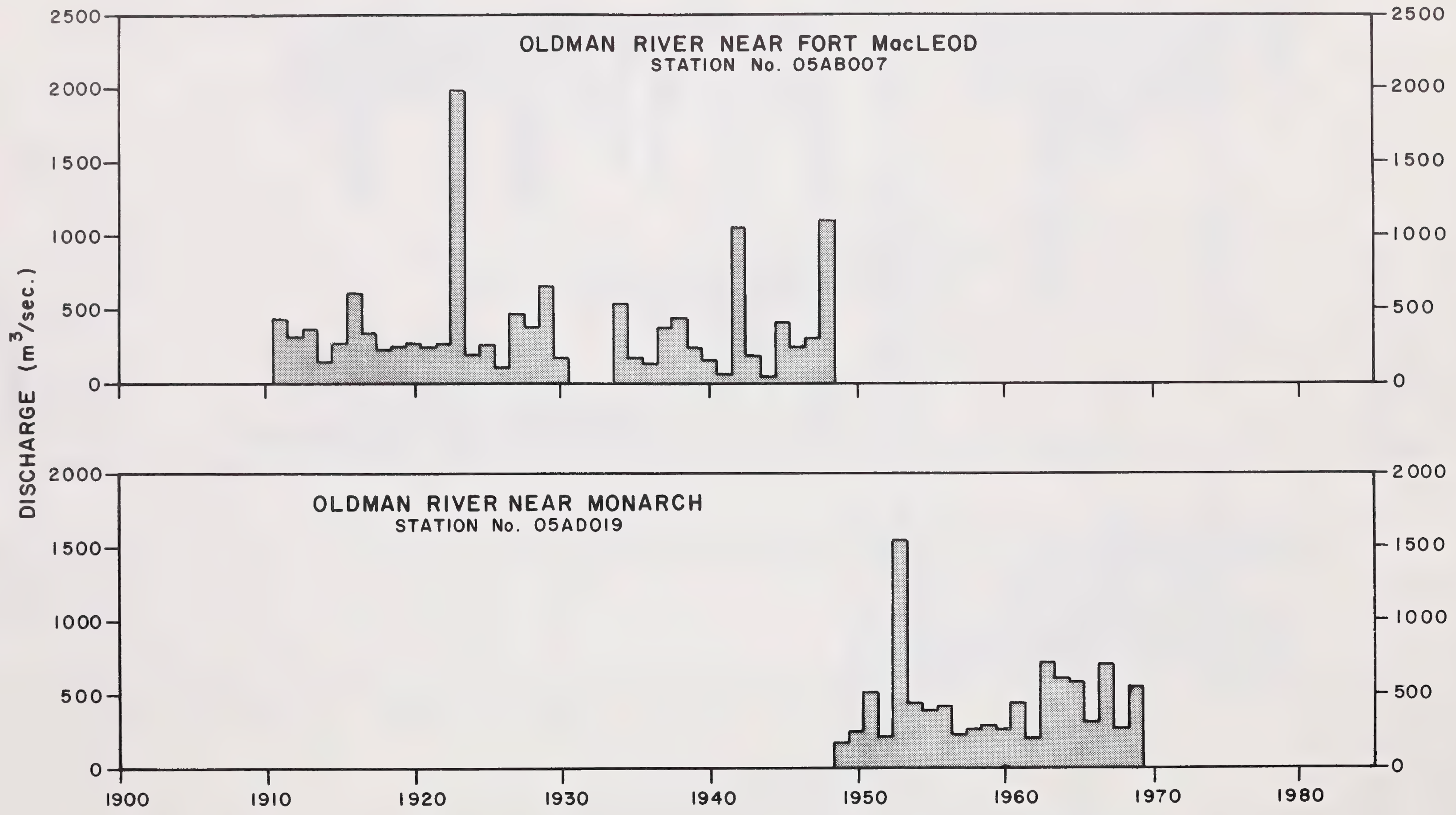


FIG. 12 HISTOGRAMS OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

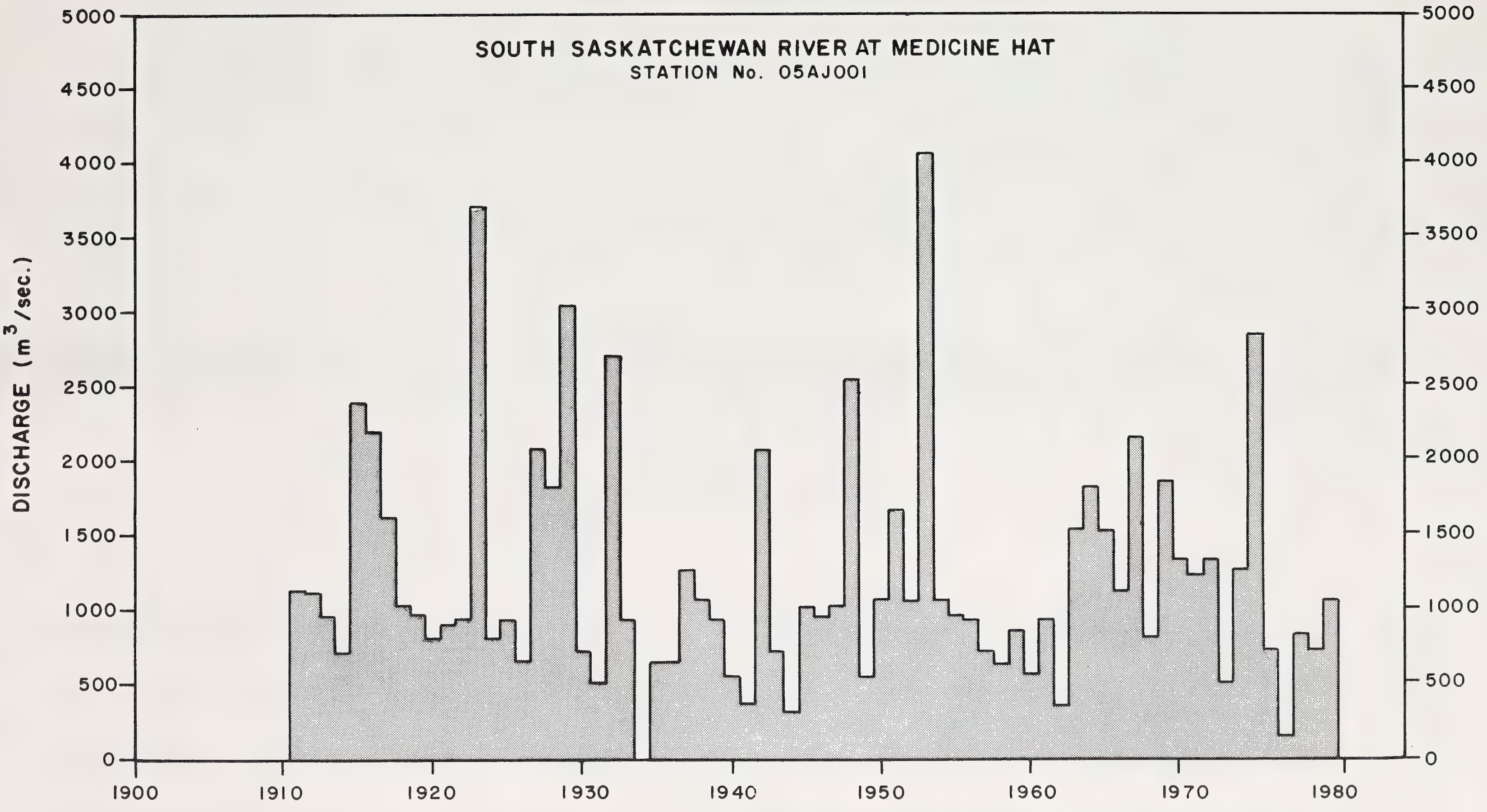


FIG. 13 HISTOGRAM OF ANNUAL MAXIMUM MEAN DAILY DISCHARGE

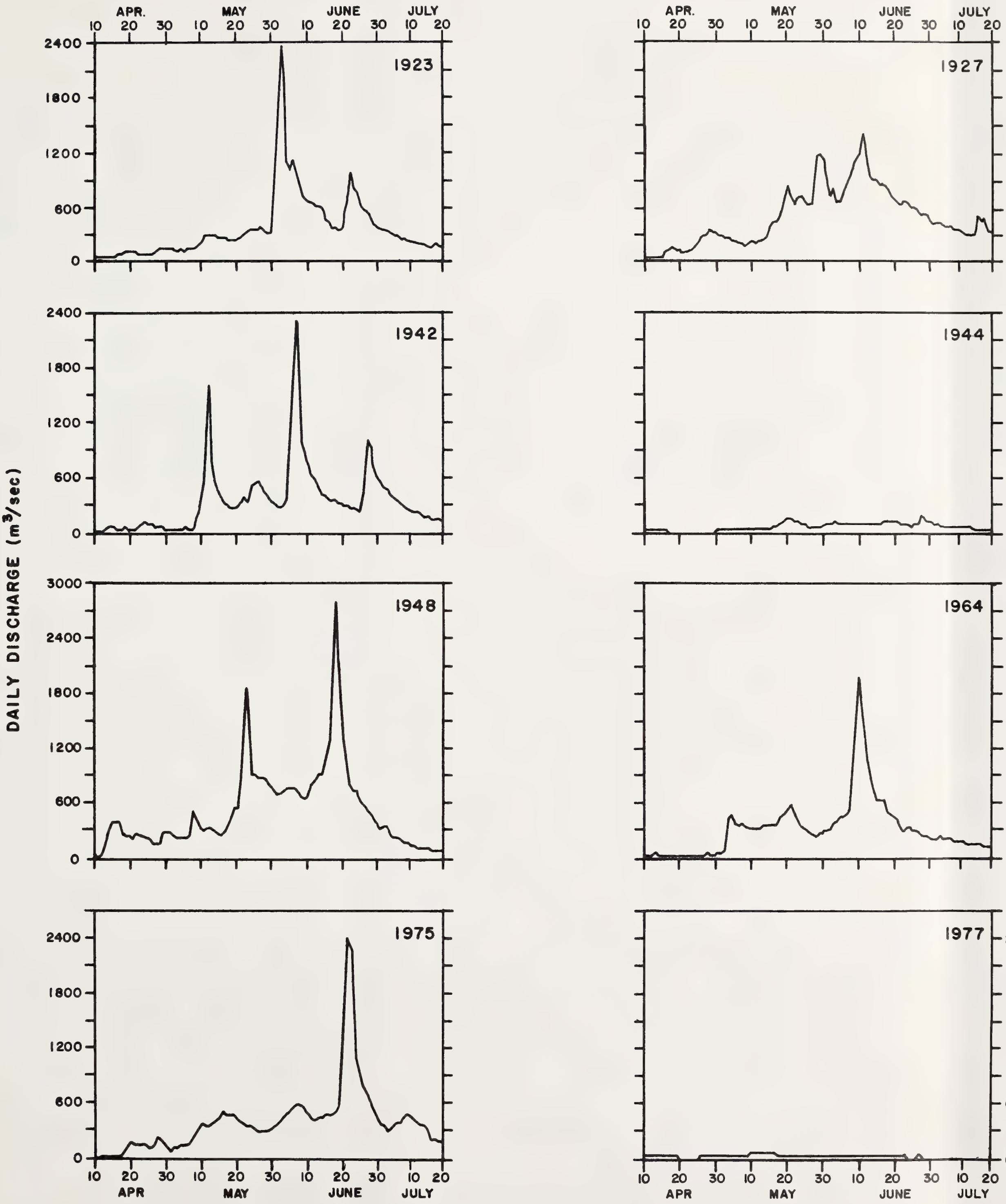
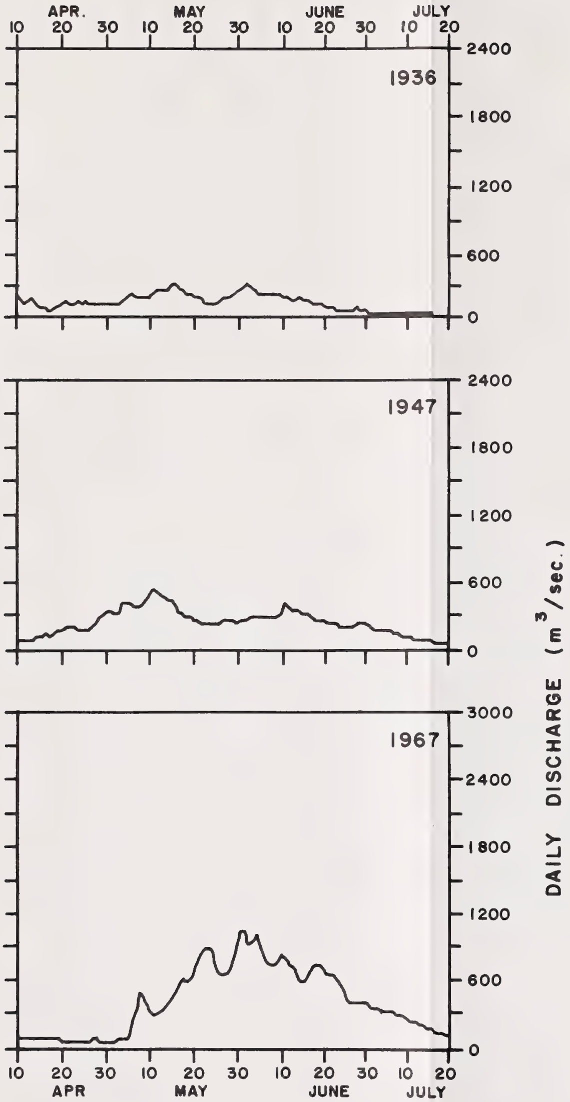


FIG. 14 SELECTED DAILY DISCHARGE HYDROGRAPHS, OLDMAN RIVER N



Oldman River Near Lethbridge
Station No. 05AD007

Daily Discharges, 1944 (cubic metres per second)

	April	May	June	July
1	--	15	88	124
2	--	16	97	110
3	--	18	104	84
4	--	22	108	78
5	--	23	104	61
6	--	24	96	58
7	--	27	86	64
8	--	29	80	58
9	--	34	84	56
10	31	38	95	54
11	26	41	97	52
12	22	33	98	50
13	19	30	101	46
14	17	27	97	48
15	15	29	103	41
16	15	35	96	37
17	14	45	92	27
18	14	68	125	26
19	14	92	131	24
20	14	121	122	22
21	13	137	114	--
22	13	146	105	--
23	13	134	98	--
24	13	116	91	--
25	13	96	80	--
26	13	84	74	--
27	14	72	76	--
28	14	63	101	--
29	13	57	166	--
30	13	59	143	--
31	--	74	--	--

Daily Discharges, 1977

	April	May	June	July
1	--	34	30	13
2	--	39	27	11
3	--	42	26	10
4	--	43	33	9
5	--	42	33	10
6	--	40	31	9
7	--	37	30	8
8	--	34	32	7
9	--	31	35	7
10	36	31	39	8
11	38	37	39	8
12	34	47	37	8
13	30	57	33	8
14	26	52	31	7
15	23	49	28	7
16	20	48	28	7
17	17	47	28	7
18	15	47	27	6
19	16	46	27	6
20	15	42	24	6
21	14	38	22	--
22	12	35	20	--
23	12	33	19	--
24	11	35	17	--
25	10	35	16	--
26	10	40	14	--
27	15	39	13	--
28	26	38	14	--
29	31	38	15	--
30	29	36	14	--
31	--	33	--	--

Note: The actual Daily Discharge Values for 1944 and 1977 are shown in the Table on this page for clarification.

IVER NEAR LETHBRIDGE (Apr. - July) Station No. 05AD007

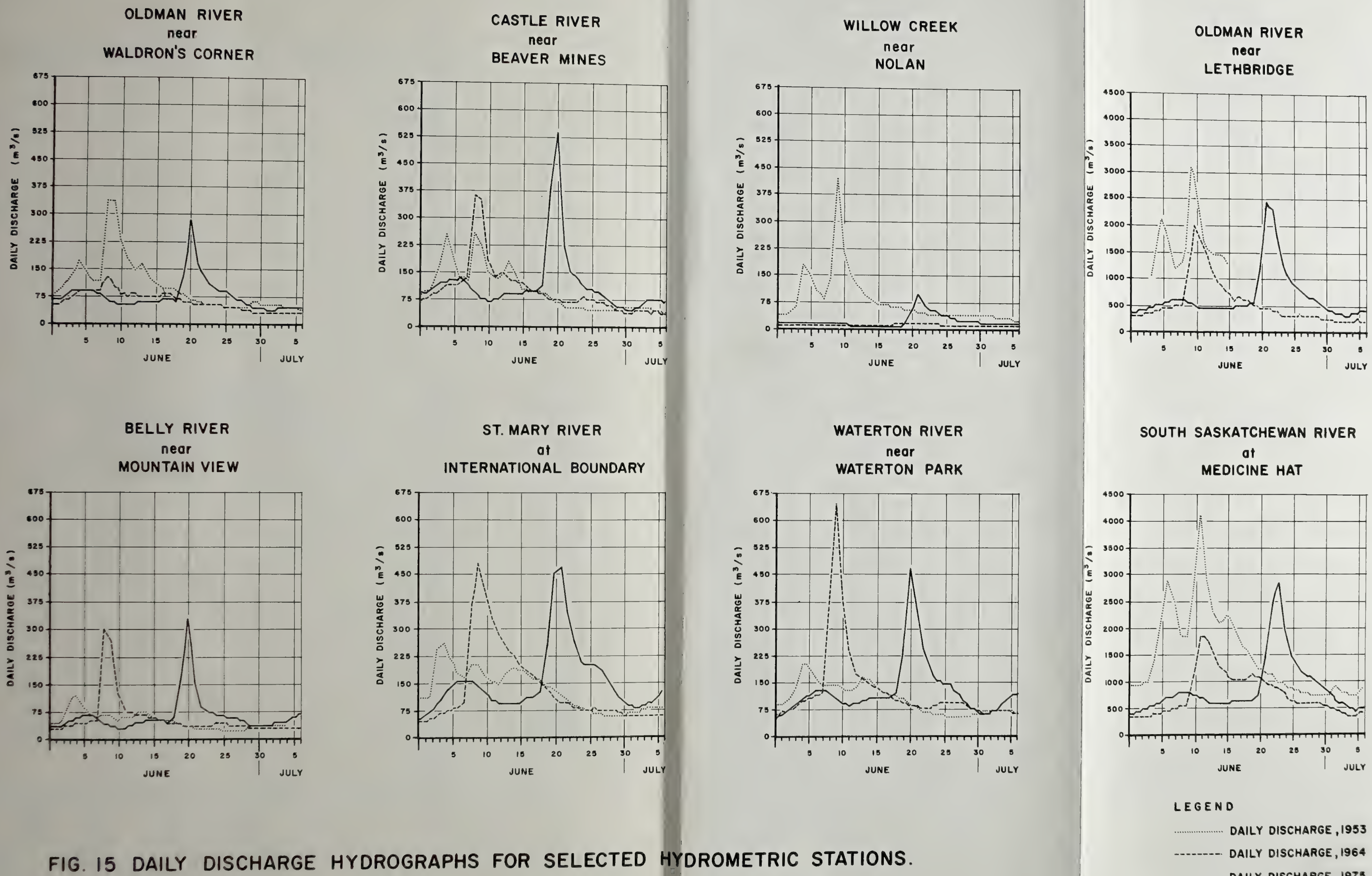


FIG. 15 DAILY DISCHARGE HYDROGRAPHS FOR SELECTED HYDROMETRIC STATIONS.

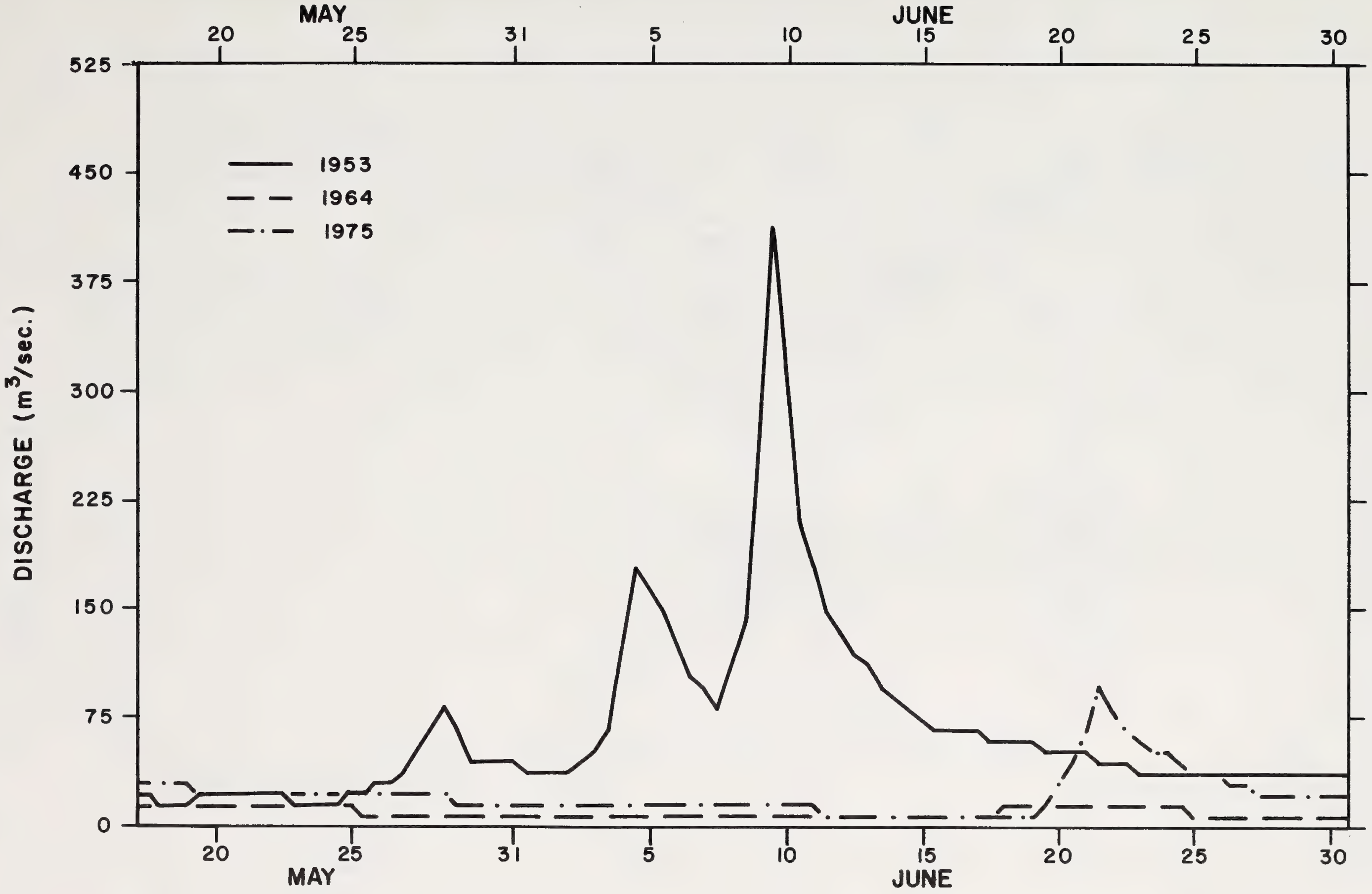


FIG. 16 SELECTED HYDROGRAPHS, MEAN DAILY FLOWS, WILLOW CREEK NEAR NOLAN. Station No. 05AB002.

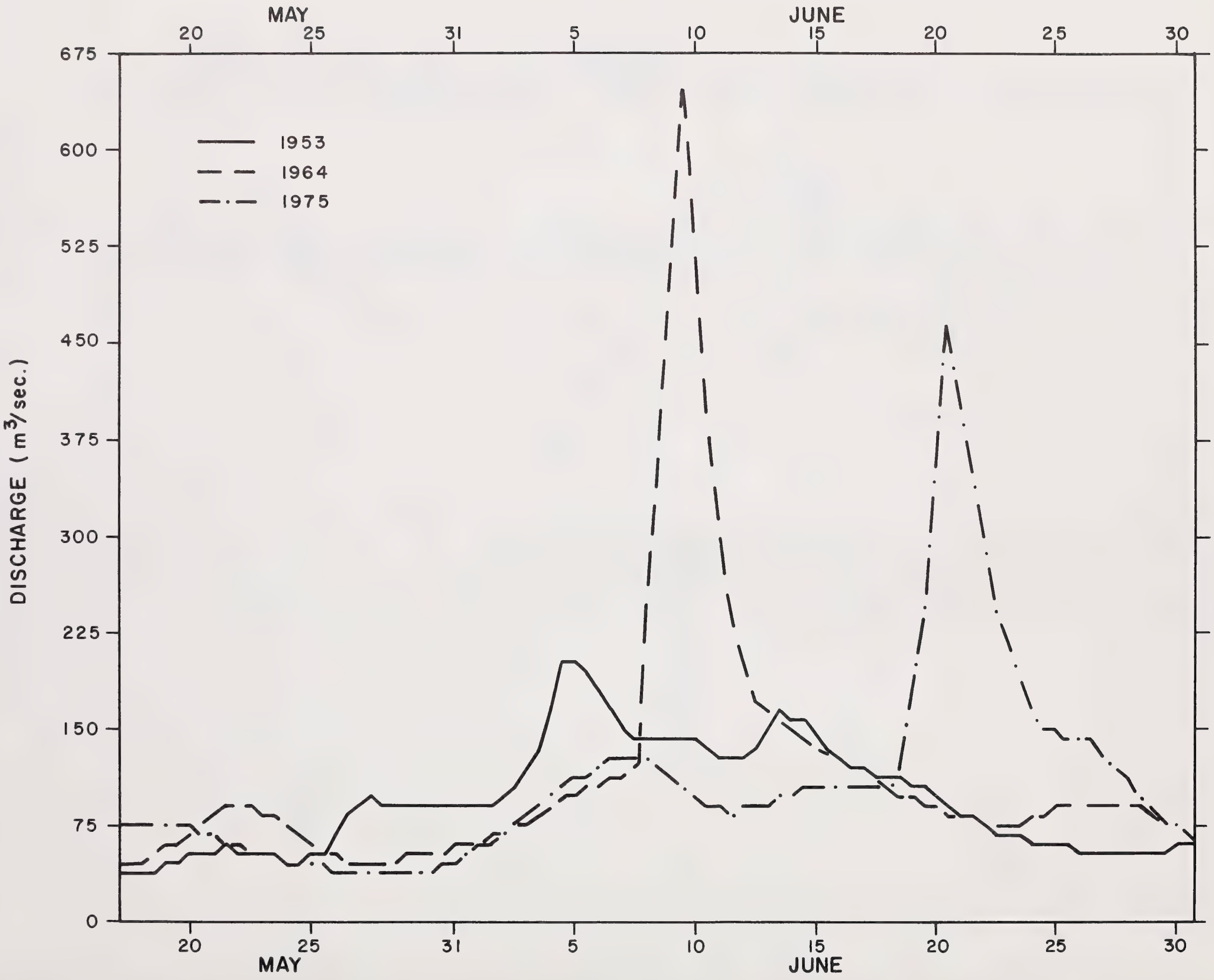


FIG. 17 SELECTED HYDROGRAPHS, MEAN DAILY FLOWS, WATERTON RIVER

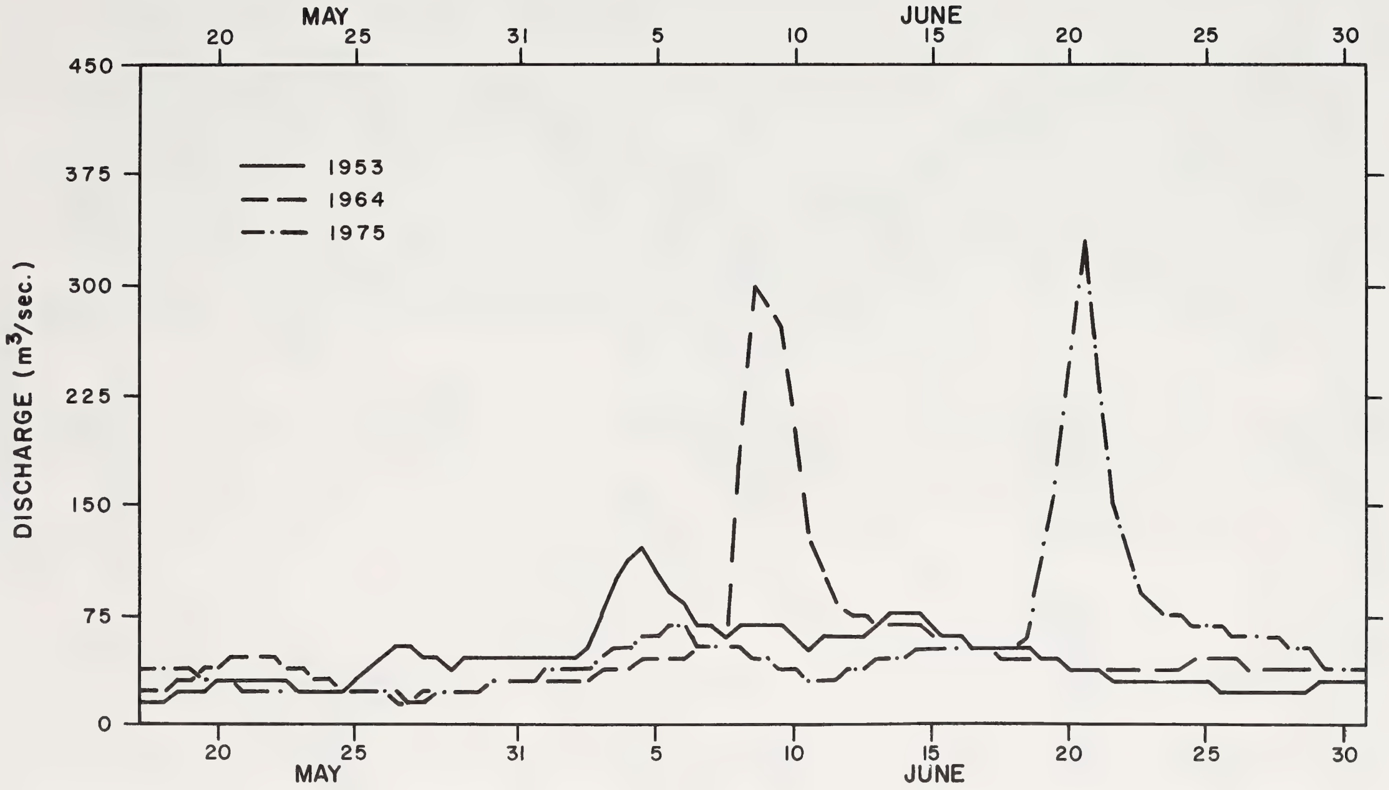


FIG. 18 SELECTED HYDROGRAPHS, MEAN DAILY FLOWS, BELLY RIVER NEAR MOUNTAIN VIEW. Station No. 05AD005.

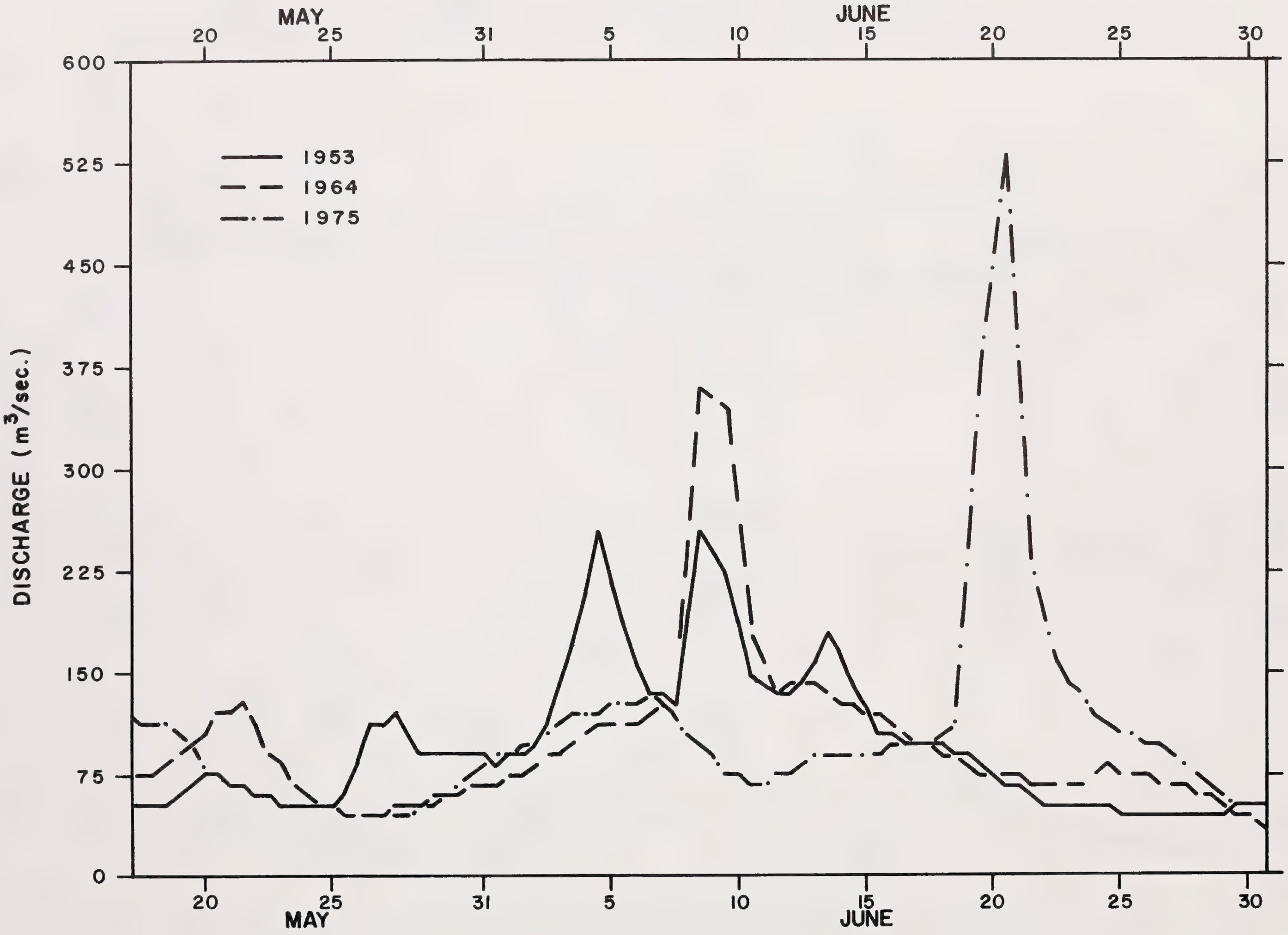


FIG. 19 SELECTED HYDROGRAPHS, MEAN DAILY FLOWS CASTLE RIVER NEAR BEAVER MINES. Station No. 05AA022.

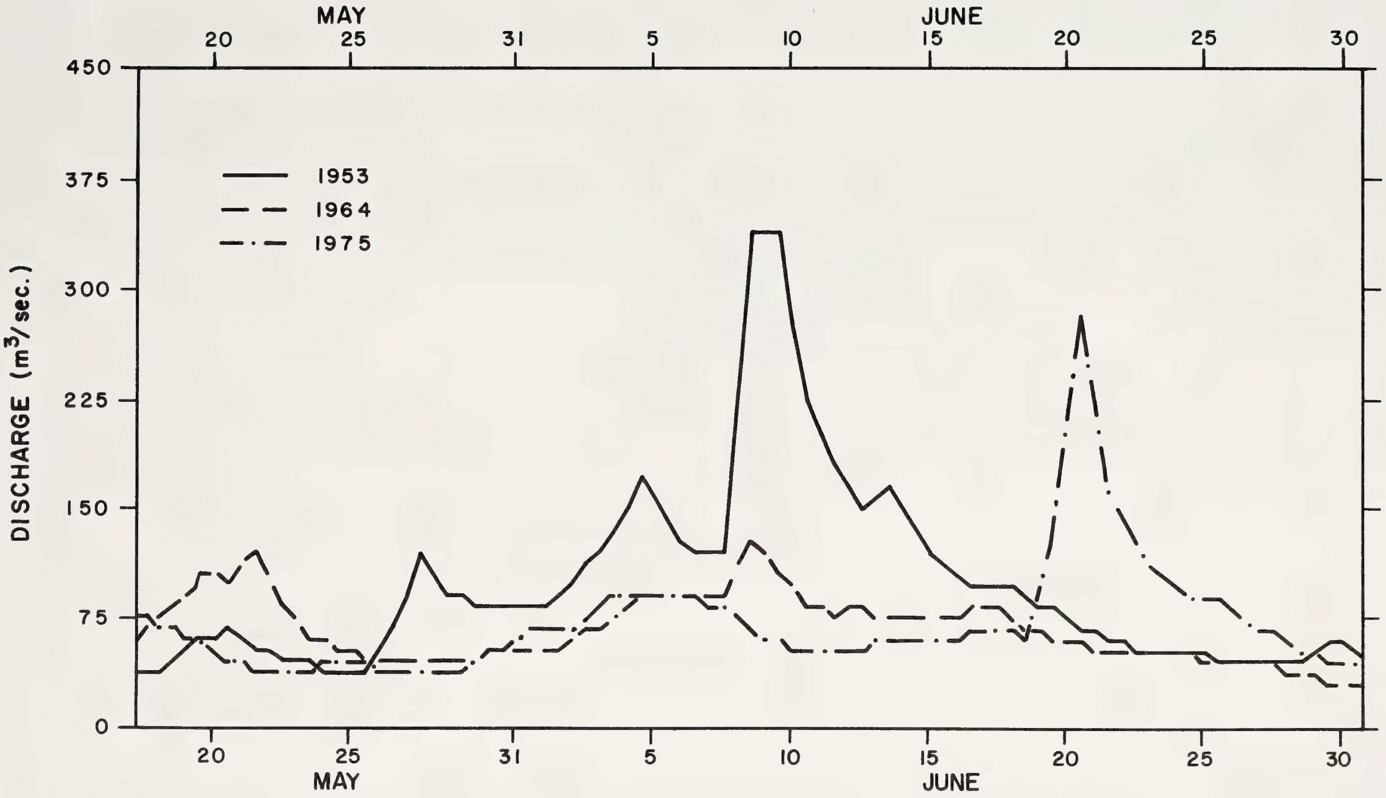


FIG. 20 SELECTED HYDROGRAPHS, MEAN DAILY FLOWS, OLDMAN RIVER NEAR WALDRON'S CORNER. Station No. 05AA023.

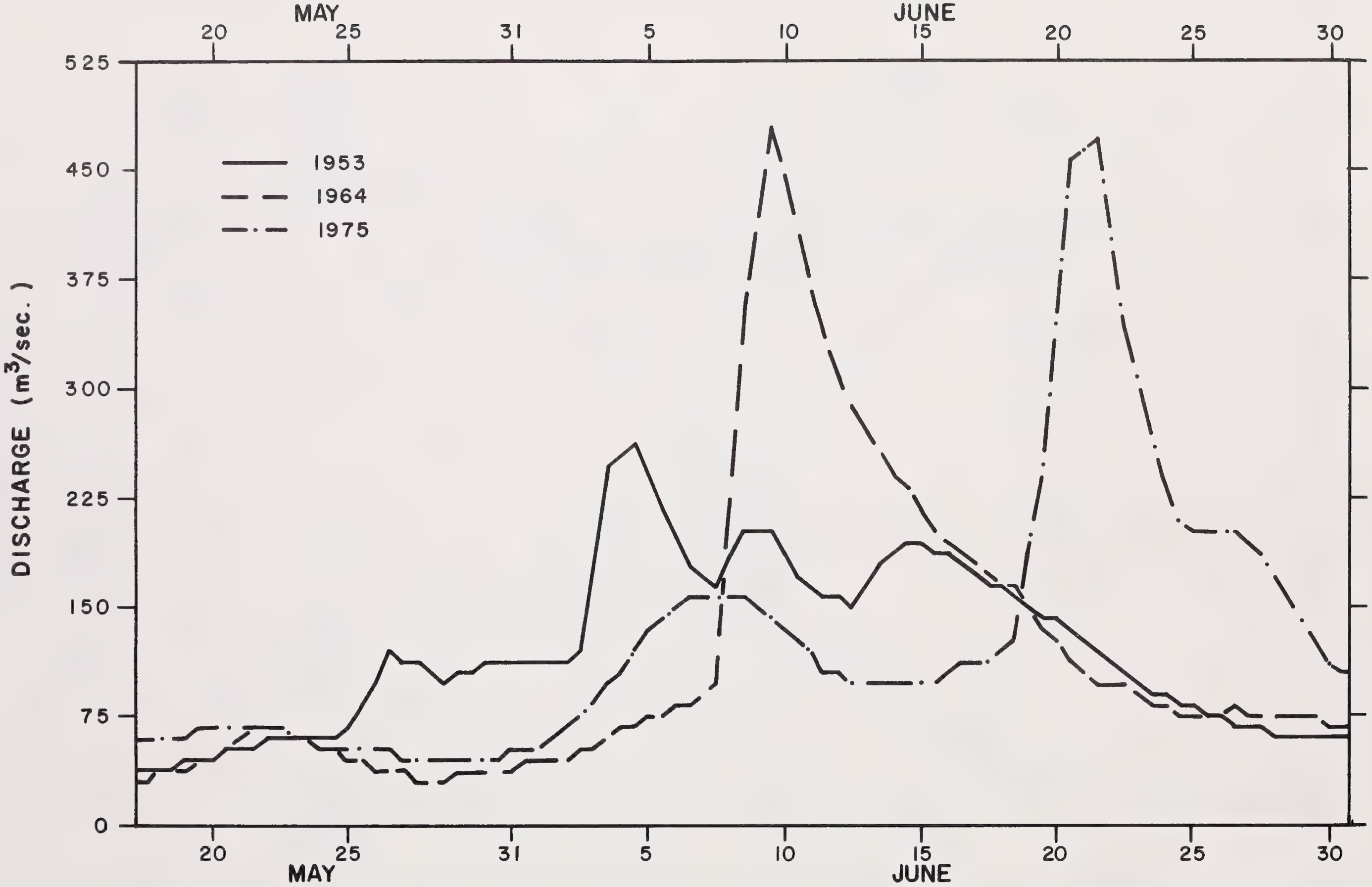


FIG. 21 SELECTED HYDROGRAPHS, MEAN DAILY FLOWS, St. MARY RIVER AT INTERNATIONAL BOUNDARY. Station No. 05AE027

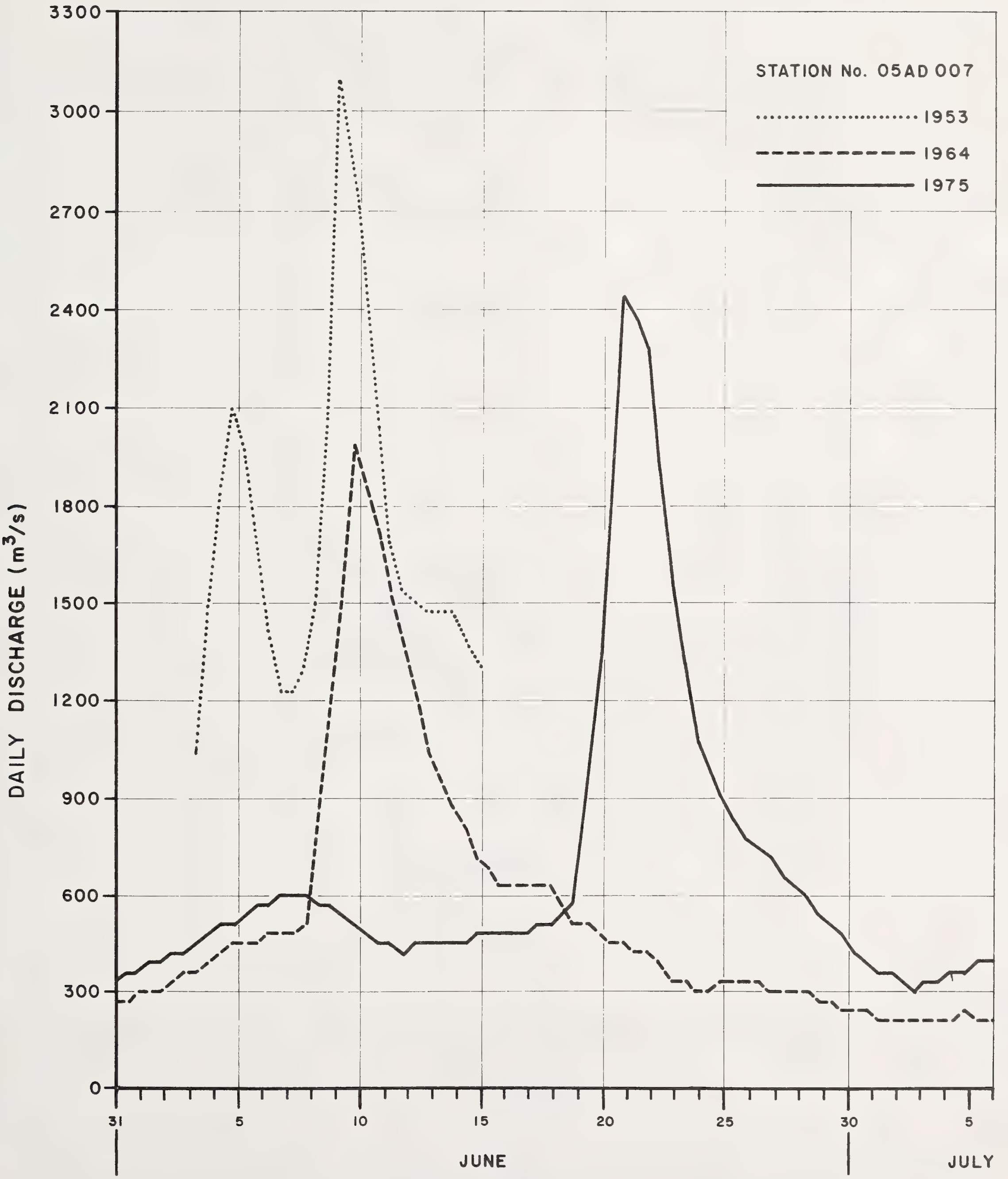


FIG. 22 SELECTED DISCHARGE HYDROGRAPHS, OLDMAN RIVER near LETHBRIDGE.

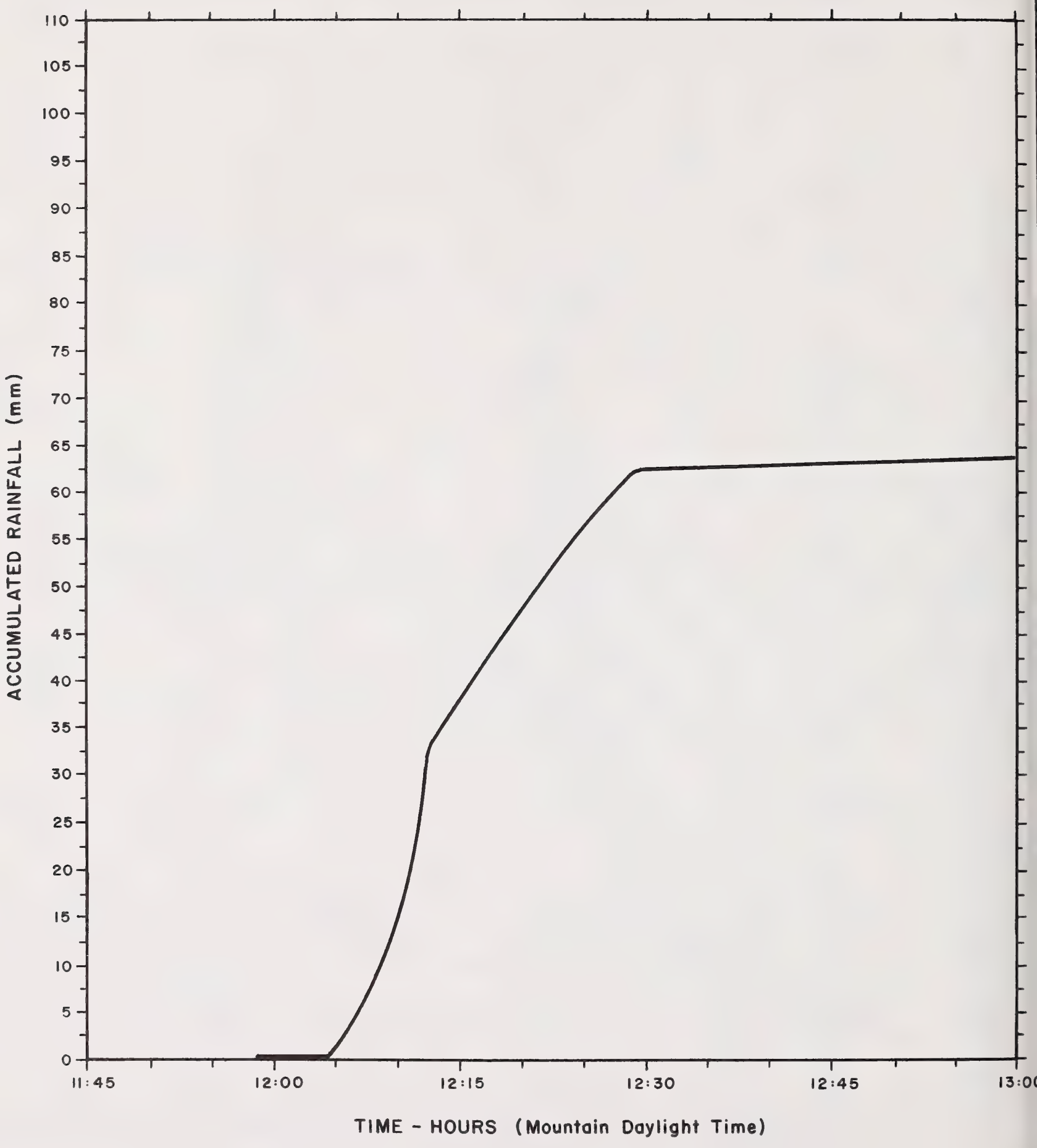


FIG. 23 MASS CURVE OF RAINFALL
LETHBRIDGE AIRPORT - JULY 1, 1982

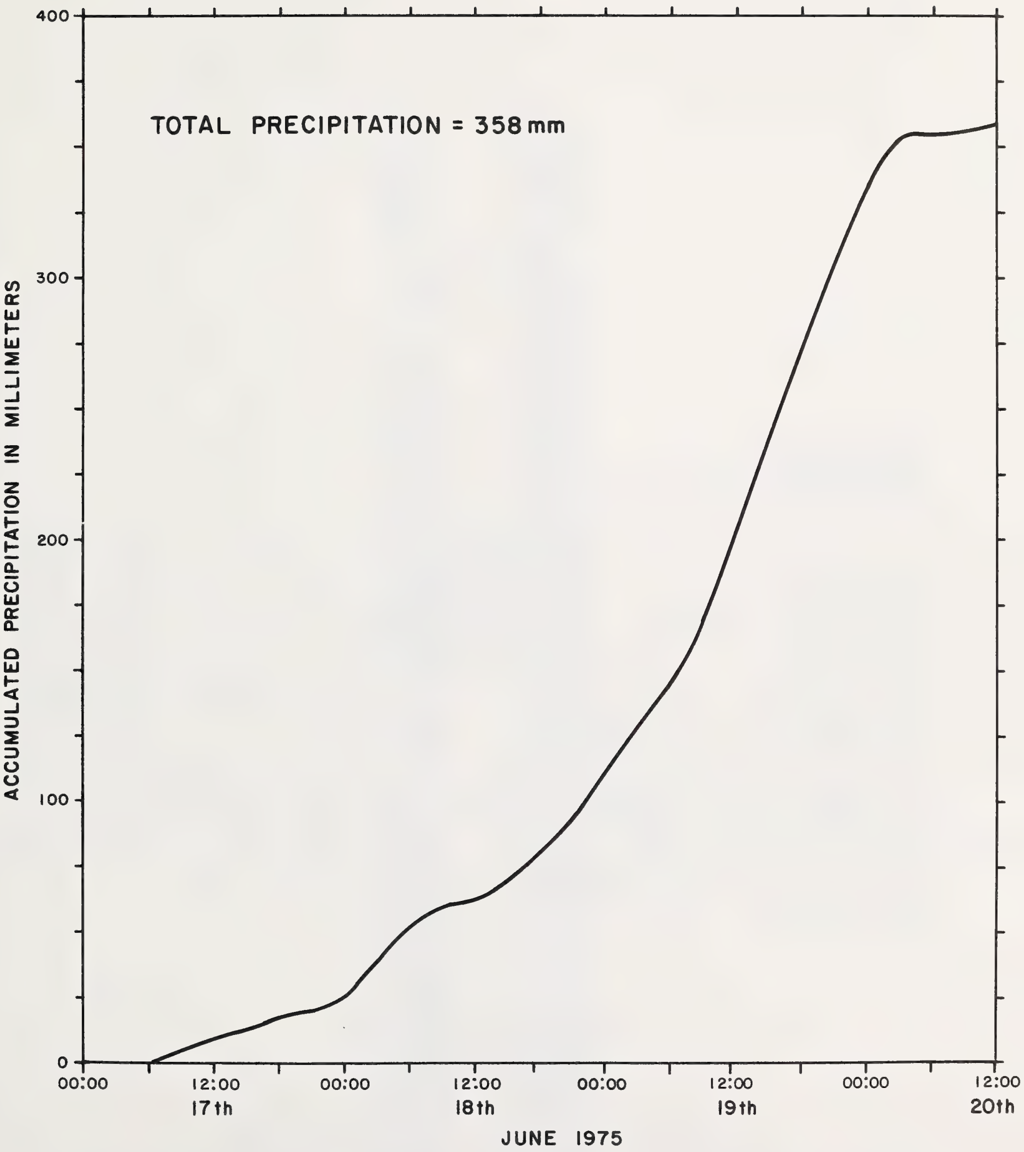
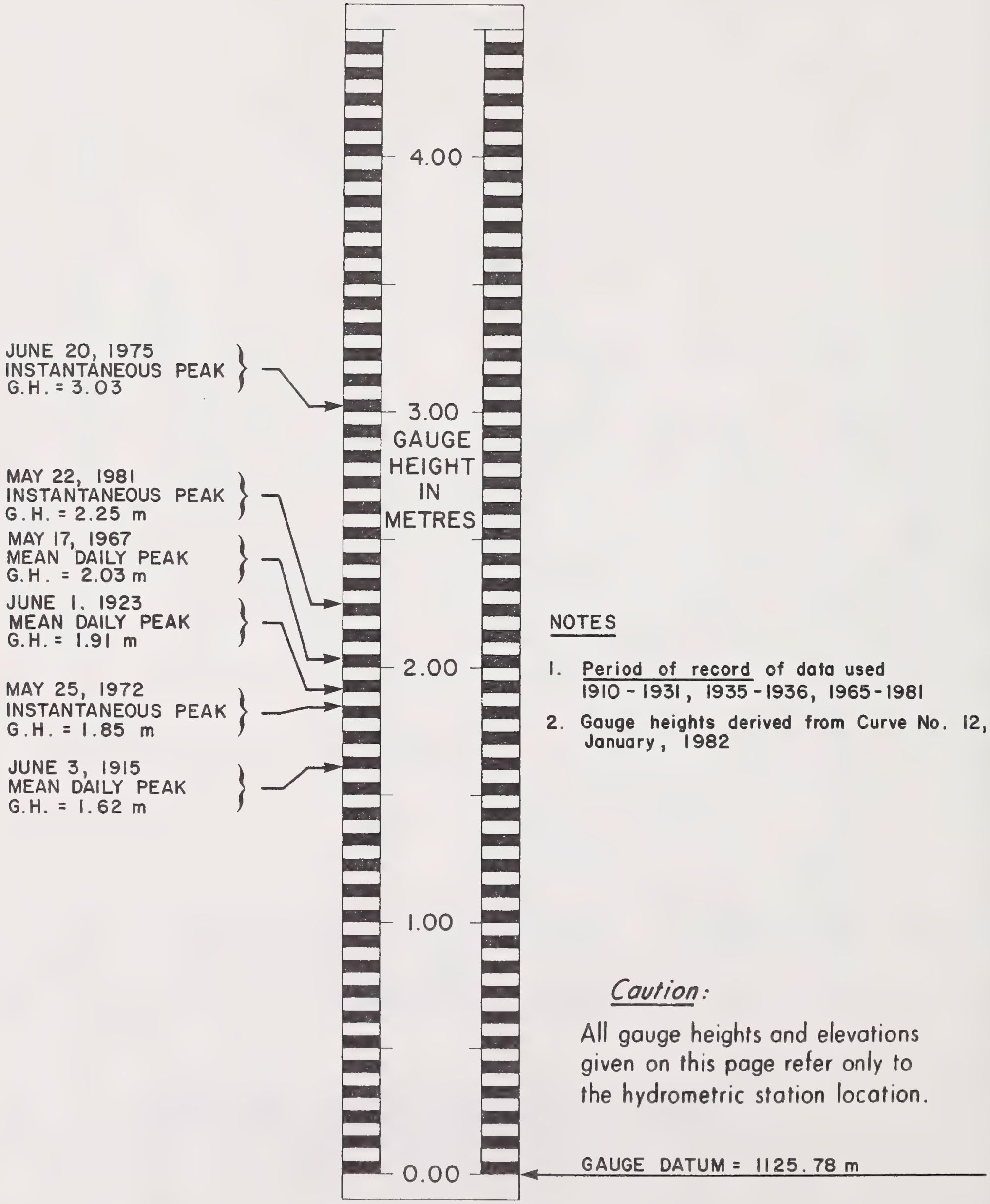


FIG. 24 MASS CURVE OF RAINFALL
WATERTON RED ROCK PRECIPITATION SITE
17-20 JUNE, 1975

SELECTED RIVER STAGE DATA
PINCHER CREEK AT PINCHER CREEK
STATION No. 05AA004



NOTES

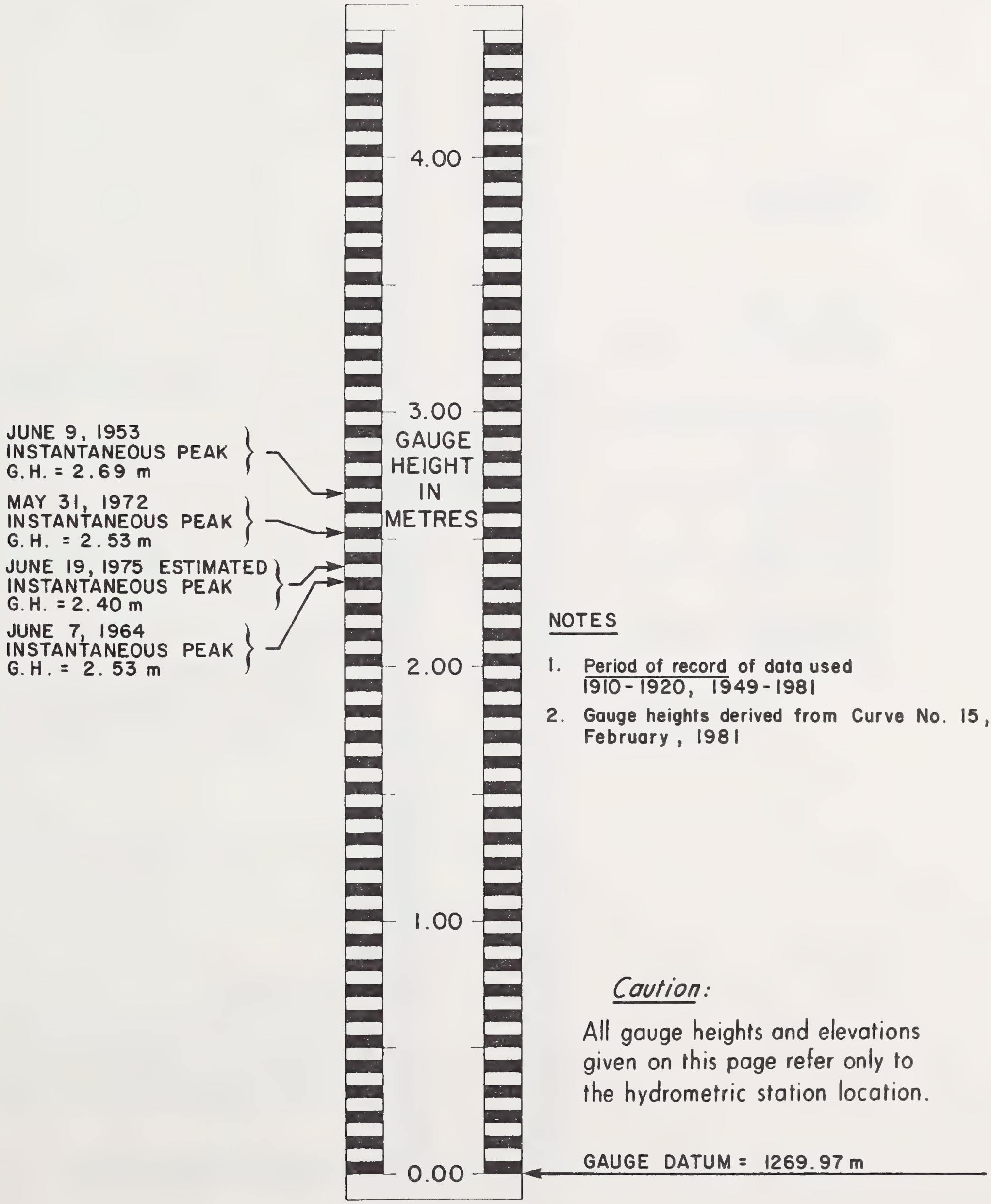
1. Period of record of data used
   1910 - 1931, 1935 - 1936, 1965 - 1981
2. Gauge heights derived from Curve No. 12, January, 1982

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 25

SELECTED RIVER STAGE DATA
CROWSNEST RIVER AT FRANK
STATION No. 05AA008



NOTES

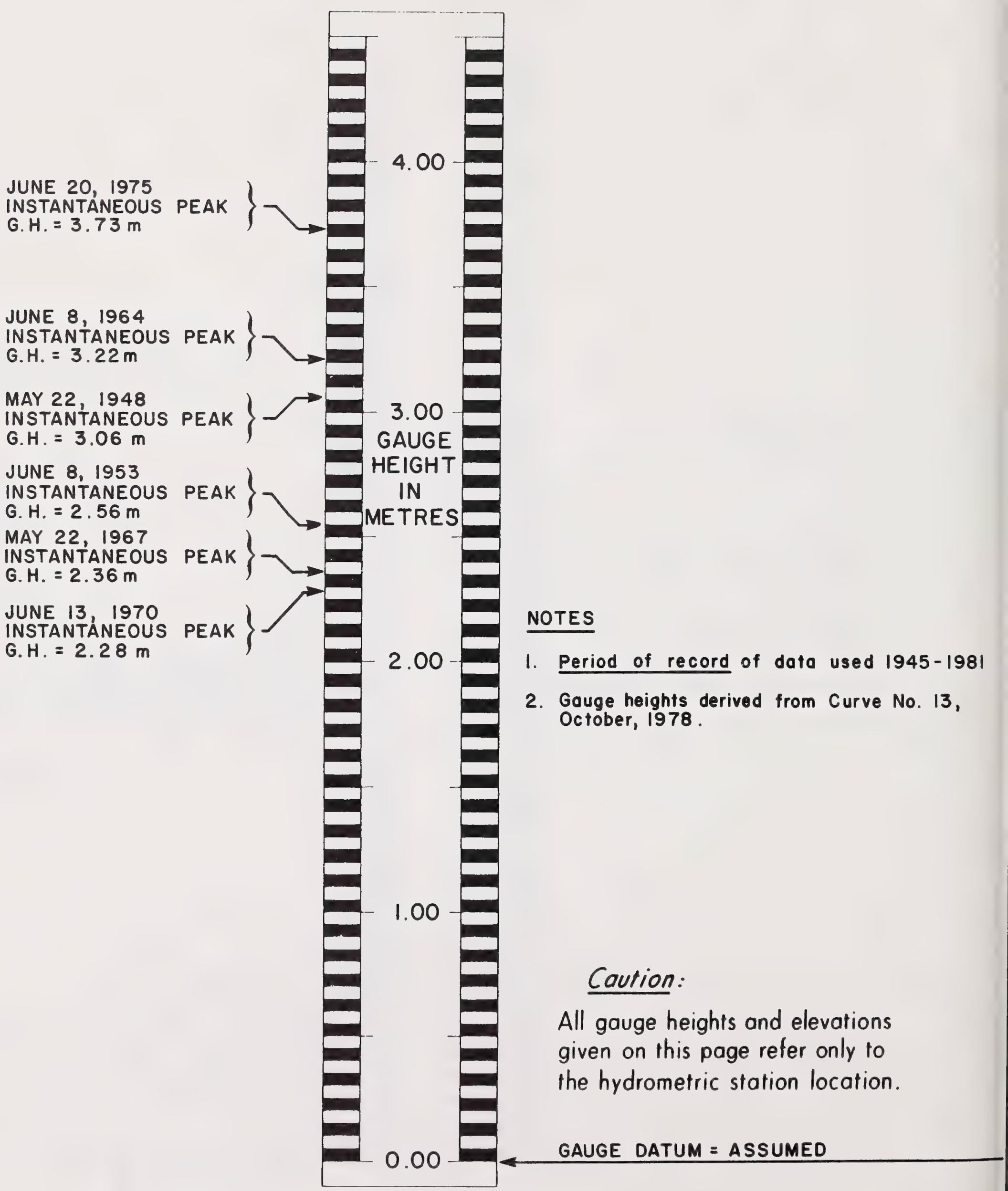
1. Period of record of data used
   1910-1920, 1949-1981
2. Gauge heights derived from Curve No. 15, February, 1981

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 26

SELECTED RIVER STAGE DATA
CASTLE RIVER NEAR BEAVER MINES
STATION No. 05AA022



NOTES

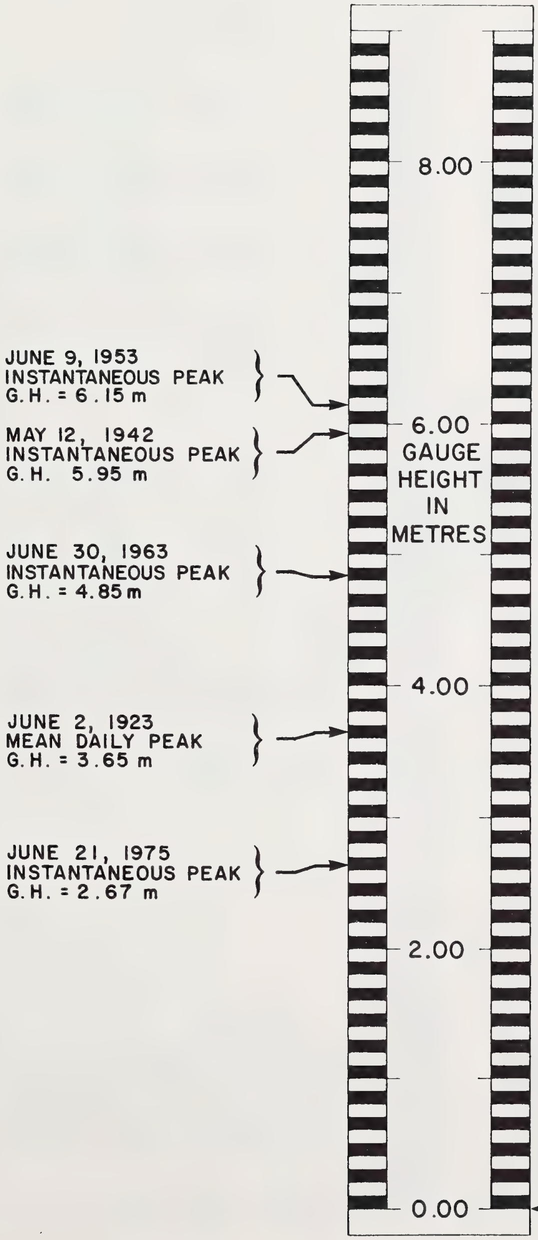
1. Period of record of data used 1945-1981
2. Gauge heights derived from Curve No. 13, October, 1978.

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 27

SELECTED RIVER STAGE DATA
WILLOW CREEK NEAR NOLAN
STATION No. 05AB002



NOTES

1. Period of record of data used
   1909-1924, 1942-1981
2. Gauge heights derived from Curve No. 15,
   January, 1982

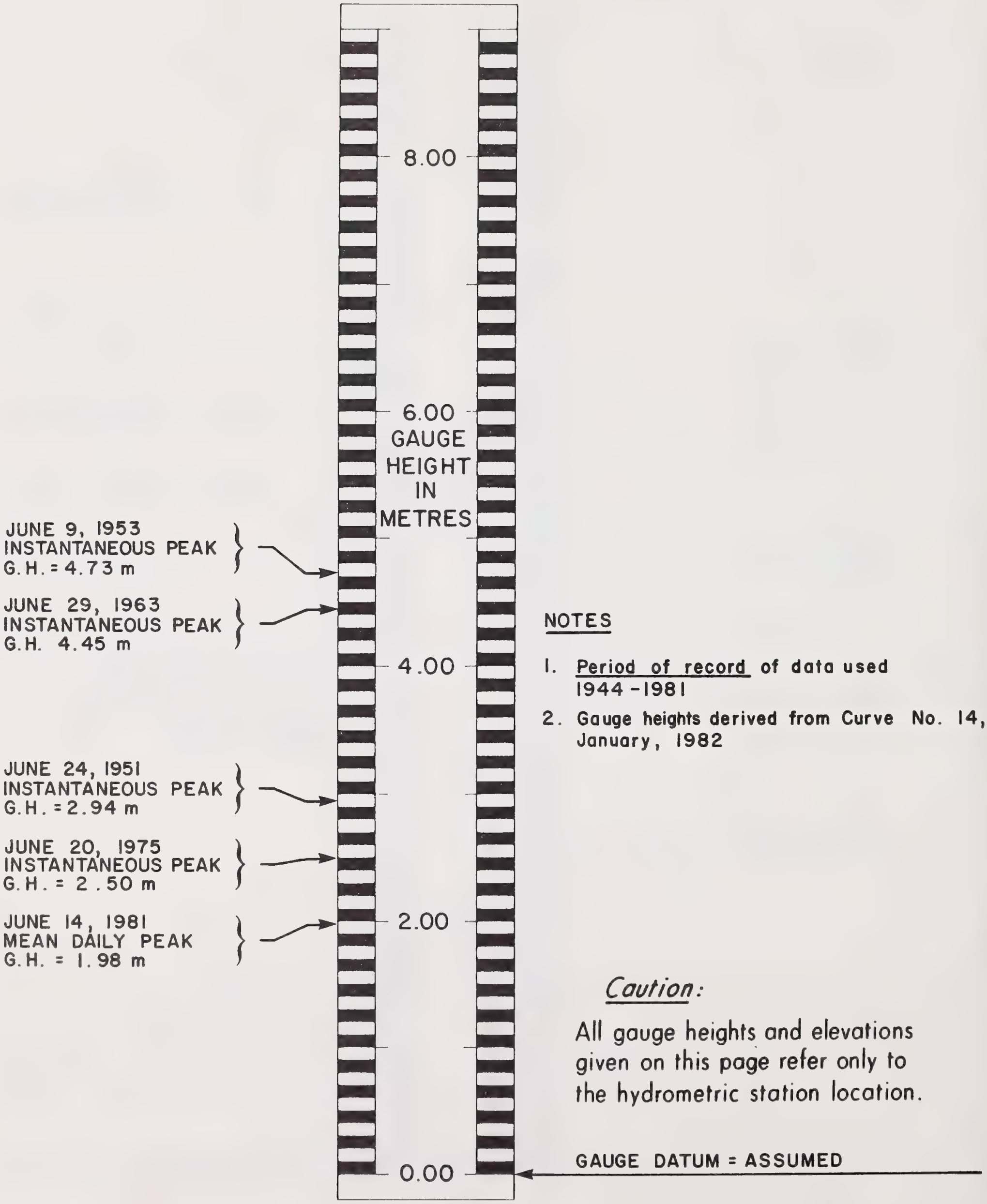
Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

GAUGE DATUM = ASSUMED

FIG. 28

SELECTED RIVER STAGE DATA
WILLOW CREEK NEAR CLARESHOLM
STATION No. 05AB021



NOTES

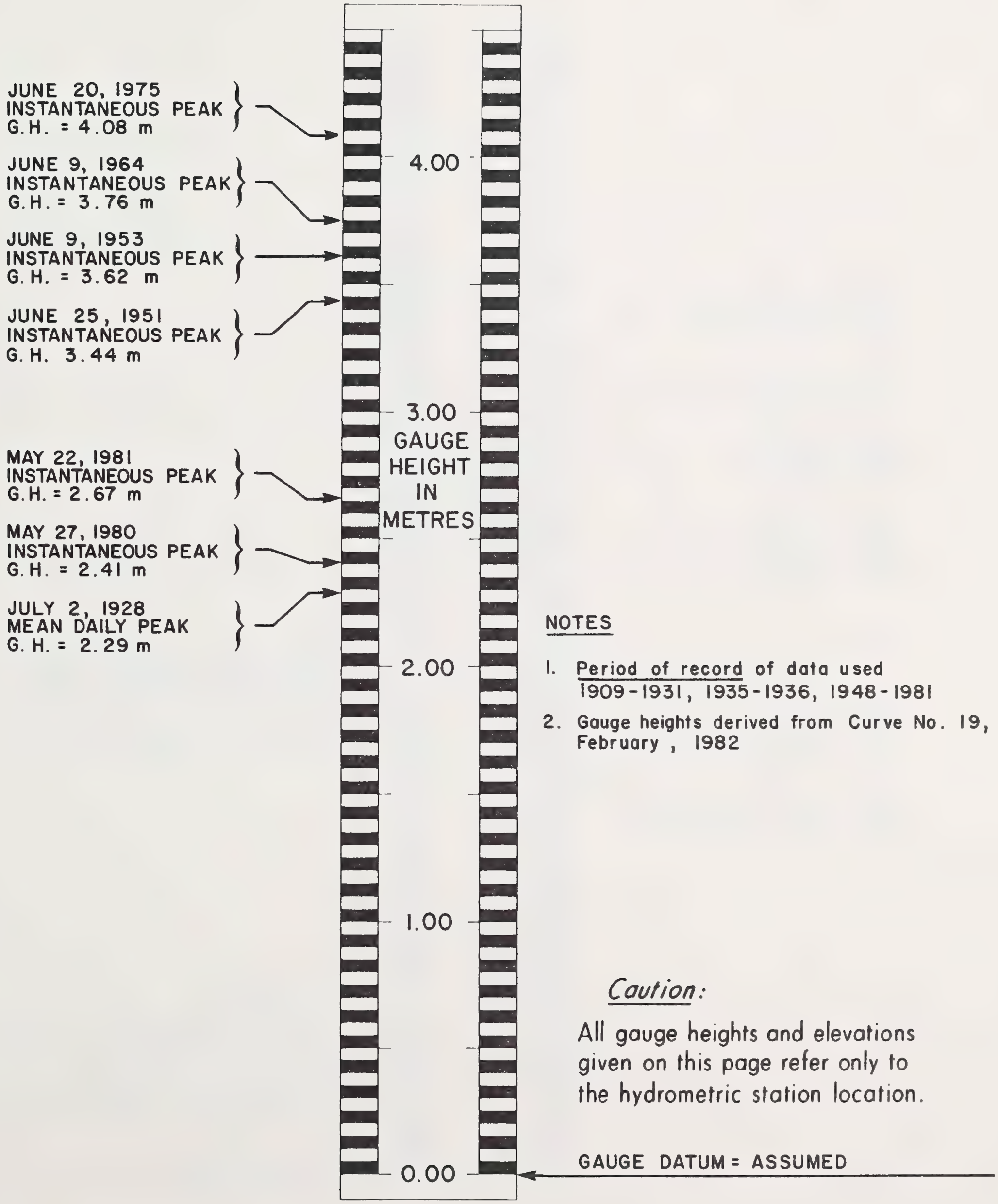
1. Period of record of data used 1944 - 1981
2. Gauge heights derived from Curve No. 14, January, 1982

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 29

SELECTED RIVER STAGE DATA
BELLY RIVER NEAR STAND OFF
STATION No. 05AD002



NOTES

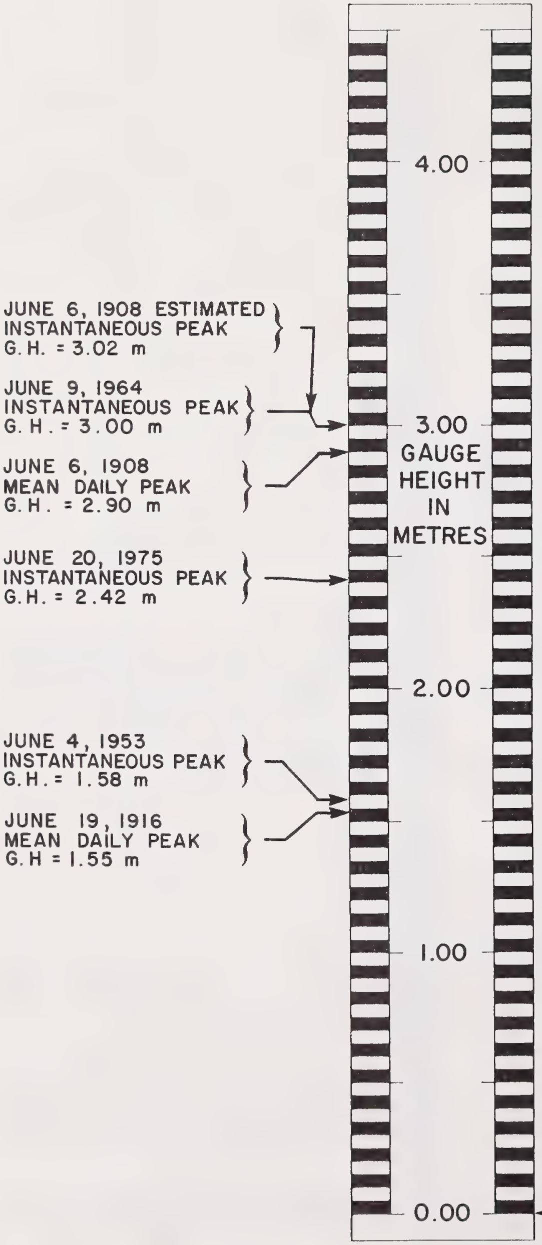
1. Period of record of data used
   1909-1931, 1935-1936, 1948-1981
2. Gauge heights derived from Curve No. 19, February, 1982

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 30

SELECTED RIVER STAGE DATA
WATERTON RIVER NEAR WATERTON PARK
STATION No. 05AD003



NOTES

1. Period of record of data used 1908-1933, 1948-1981
2. Gauge heights derived from Curve No. 13, December, 1976

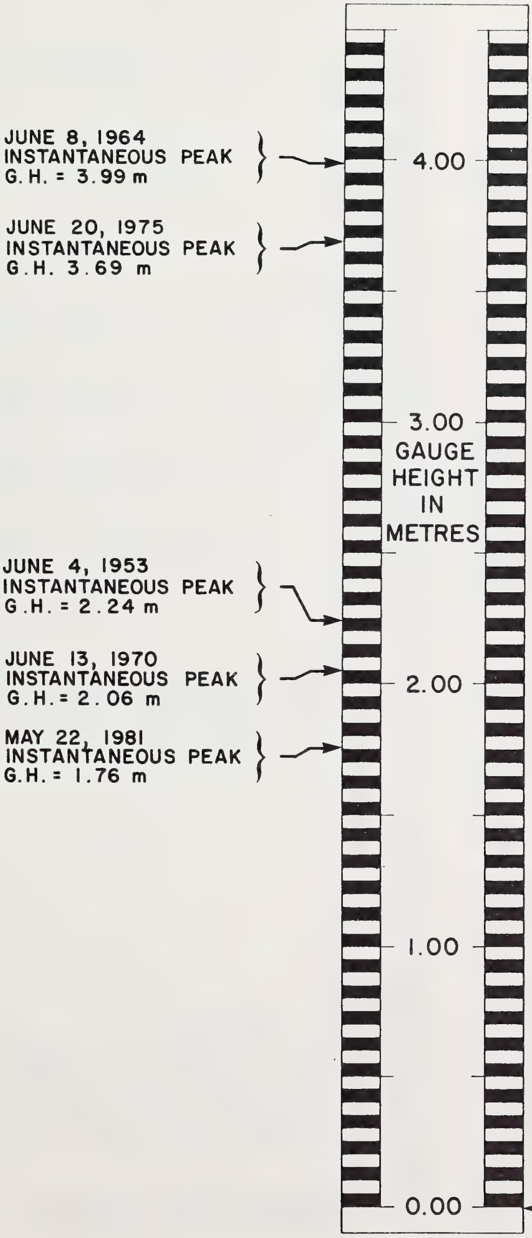
Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.
(derived from Curve No. 13, Dec., 1976)

GAUGE DATUM = 1276.16 m

FIG. 31

SELECTED RIVER STAGE DATA
BELLY RIVER NEAR MOUNTAIN VIEW
STATION No. 05AD005



NOTES

1. Period of record of data used 1911 - 1981
2. Gauge heights derived from Curve No. 12, December, 1975

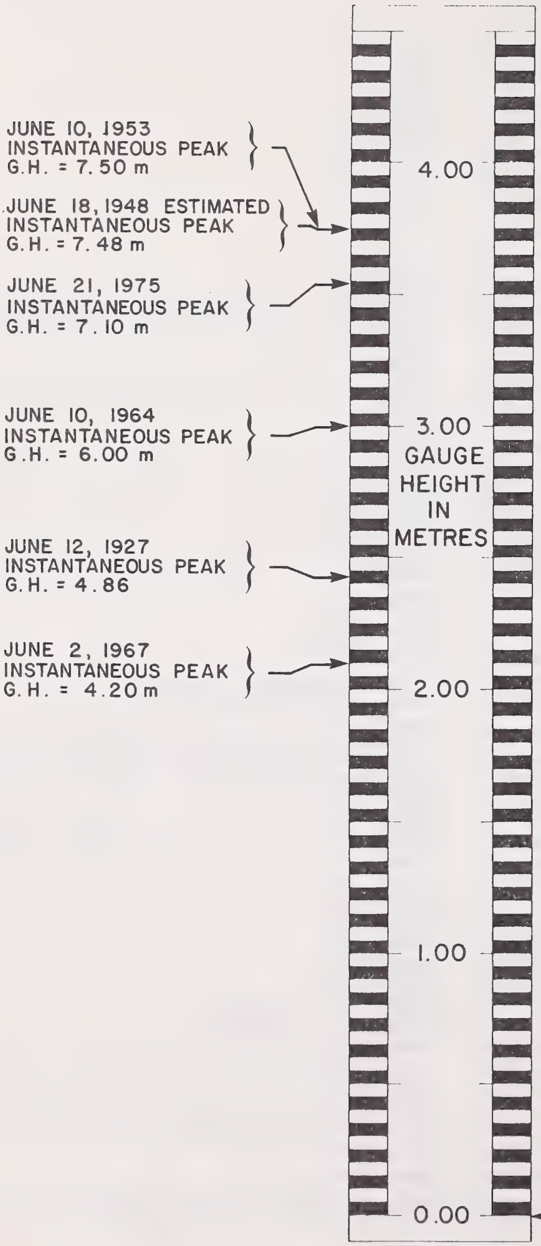
Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

GAUGE DATUM = ASSUMED

FIG. 32

SELECTED RIVER STAGE DATA
OLDMAN RIVER NEAR LETHBRIDGE
STATION No. 05AD007



NOTES

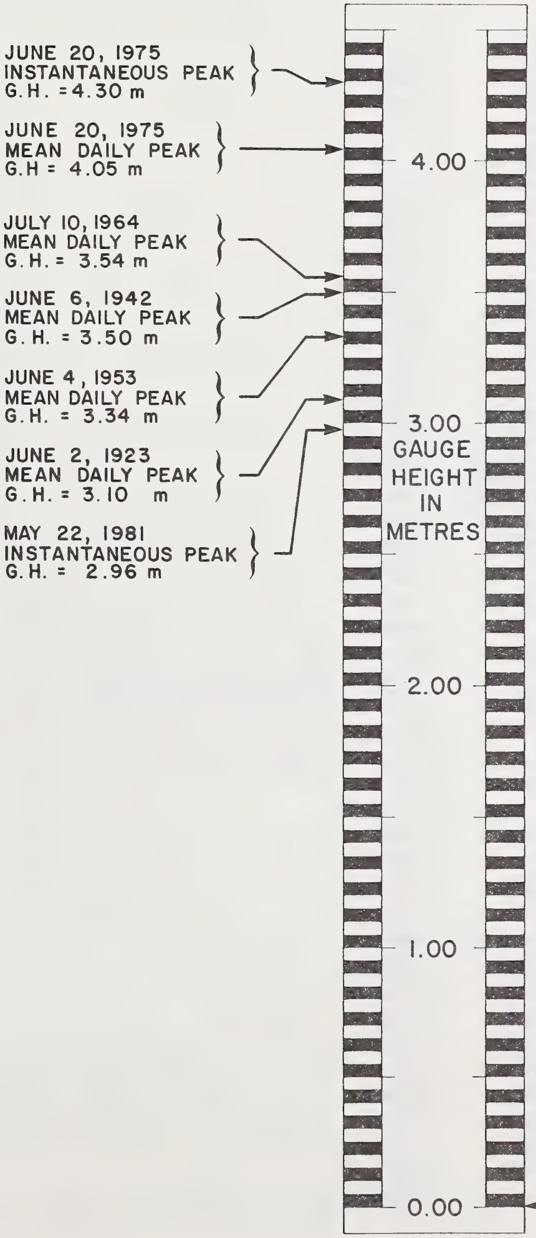
1. Period of record of data used
1911 - 1948, 1953, 1957-1981
2. Gauge heights derived from Curve No. 11, February, 1981

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 33

SELECTED RIVER STAGE DATA
WATERTON RIVER NEAR GLENWOOD
STATION No. 05AD028



NOTES

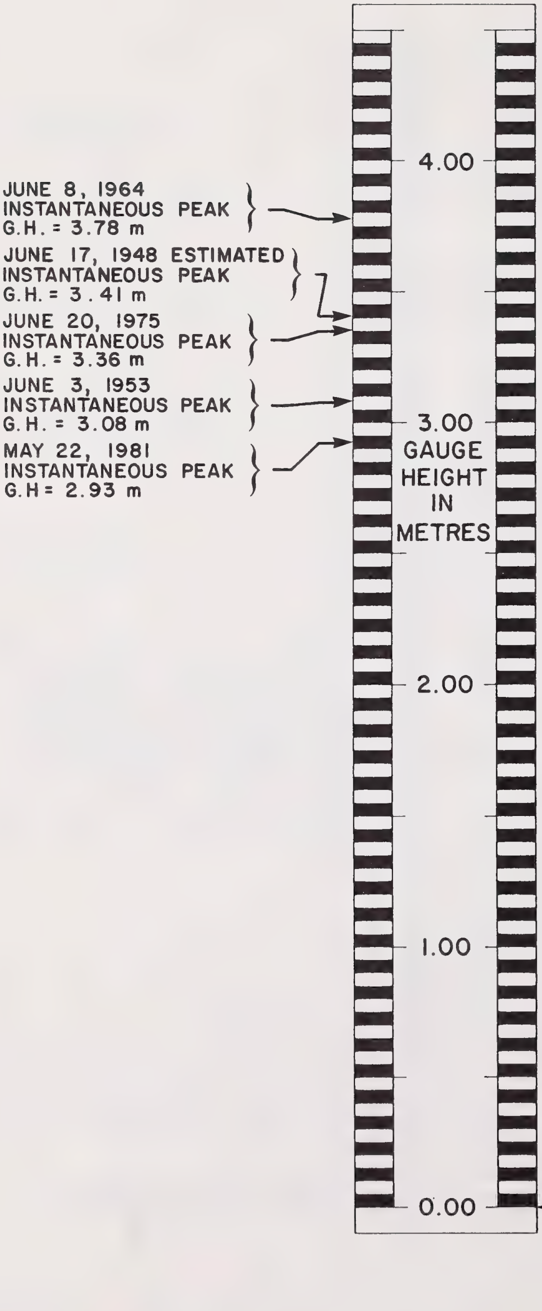
1. Period of record of data used
   No. 05A9D008 - Waterton River near Stand Off 1916 - 1966
   No. 05AD028 - Waterton River near Glenwood 1967 - 1981
2. Gauge heights derived from Curve No. 9, February, 1983

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 34

SELECTED RIVER STAGE DATA
LEE CREEK AT CARDSTON
STATION No. 05AE002



NOTES

1. Period of record of data used 1909-1914, 1921-1981
2. Gauge heights derived from Curve No. 19, January, 1981

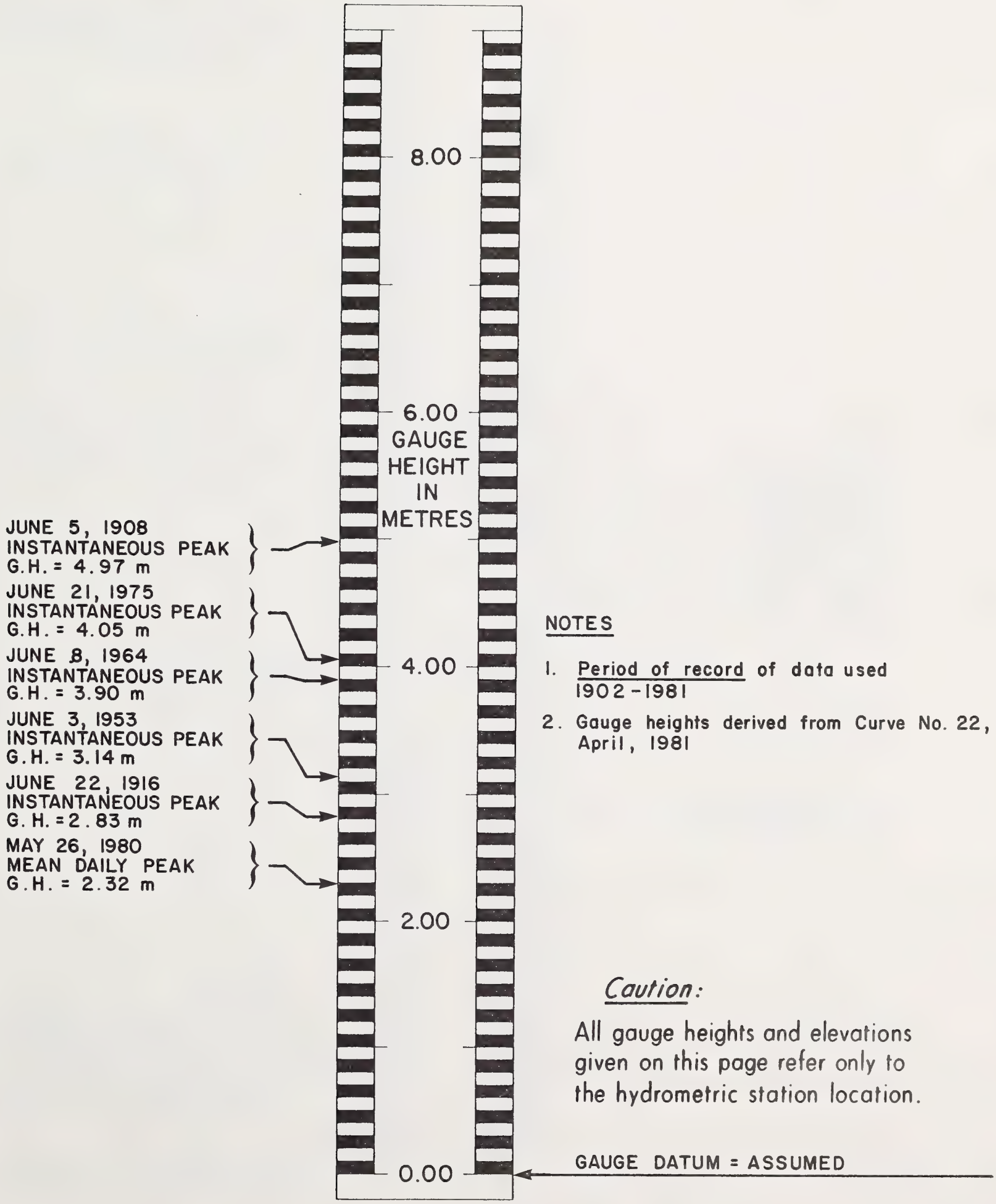
Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

GAUGE DATUM = 1127.65 m

FIG. 35

SELECTED RIVER STAGE DATA
ST. MARY RIVER AT INTERNATIONAL BOUNDARY
STATION No. 05AE027



NOTES

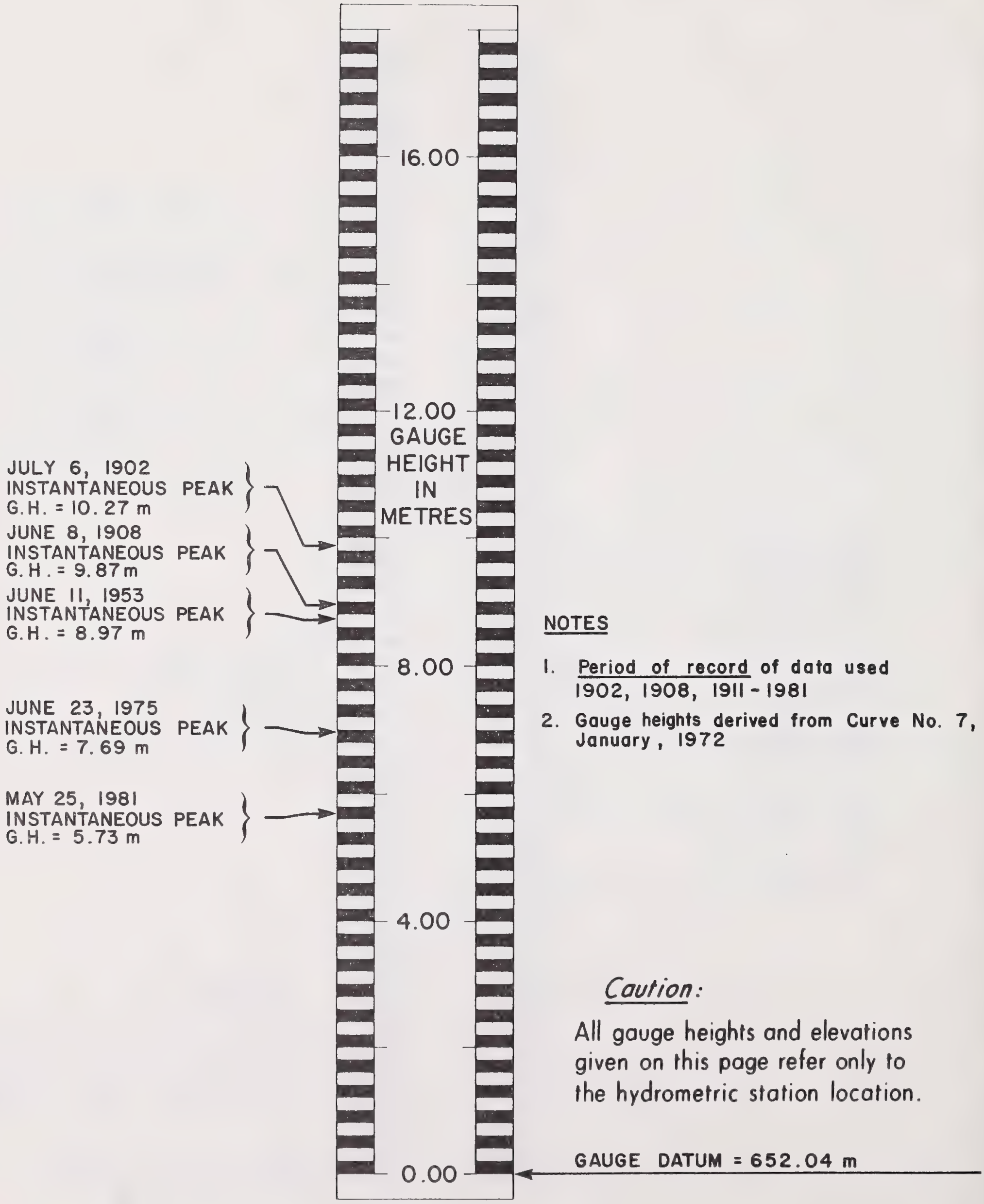
1. Period of record of data used 1902-1981
2. Gauge heights derived from Curve No. 22, April, 1981

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 36

SELECTED RIVER STAGE DATA
SOUTH SASKATCHEWAN RIVER AT MEDICINE HAT
STATION No. 05AJ001



NOTES

1. Period of record of data used 1902, 1908, 1911 - 1981
2. Gauge heights derived from Curve No. 7, January, 1972

Caution:

All gauge heights and elevations given on this page refer only to the hydrometric station location.

FIG. 37

SELECTED STAGE DATA
WATERTON LAKE AT WATERTON PARK
STATION No. 05AD025

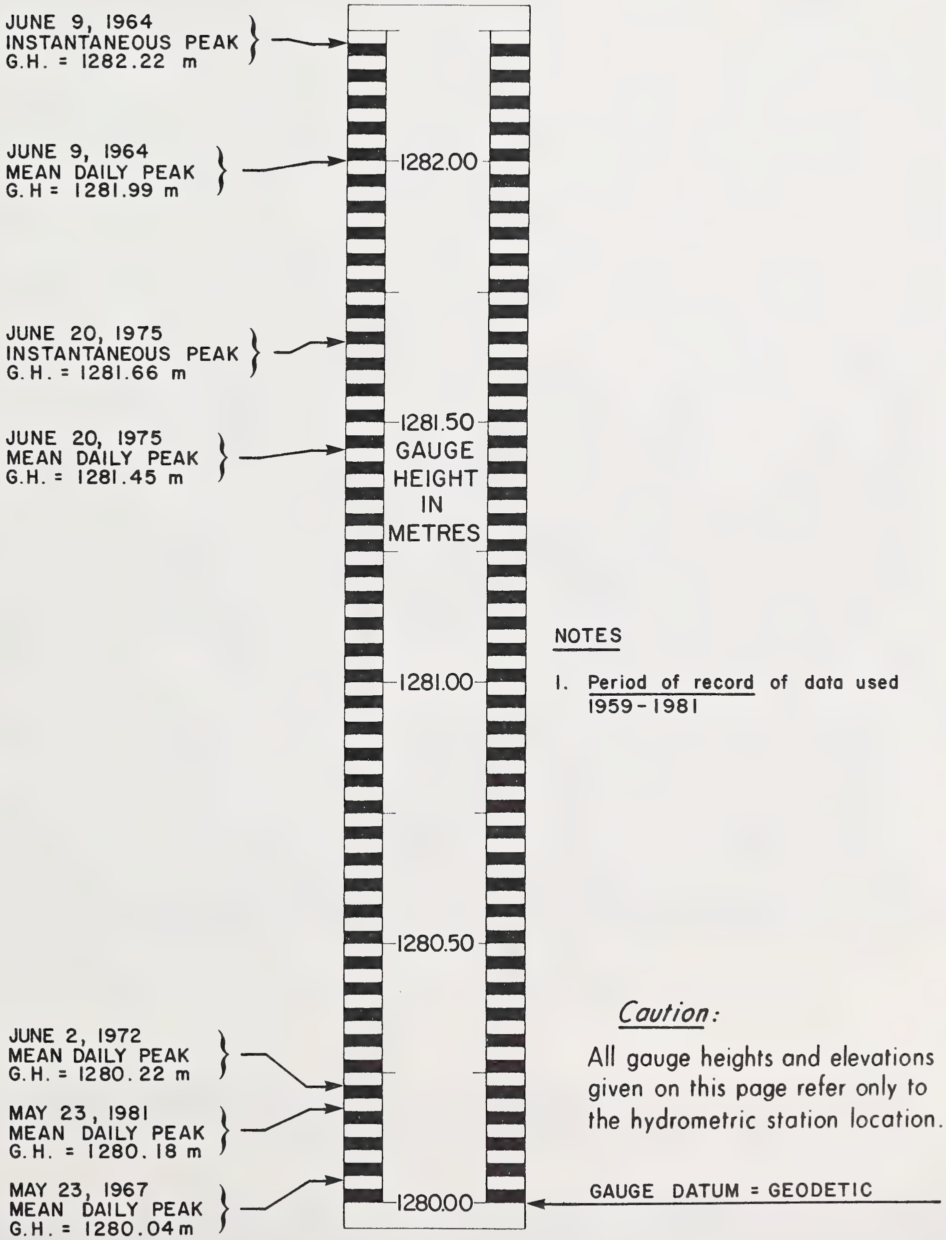
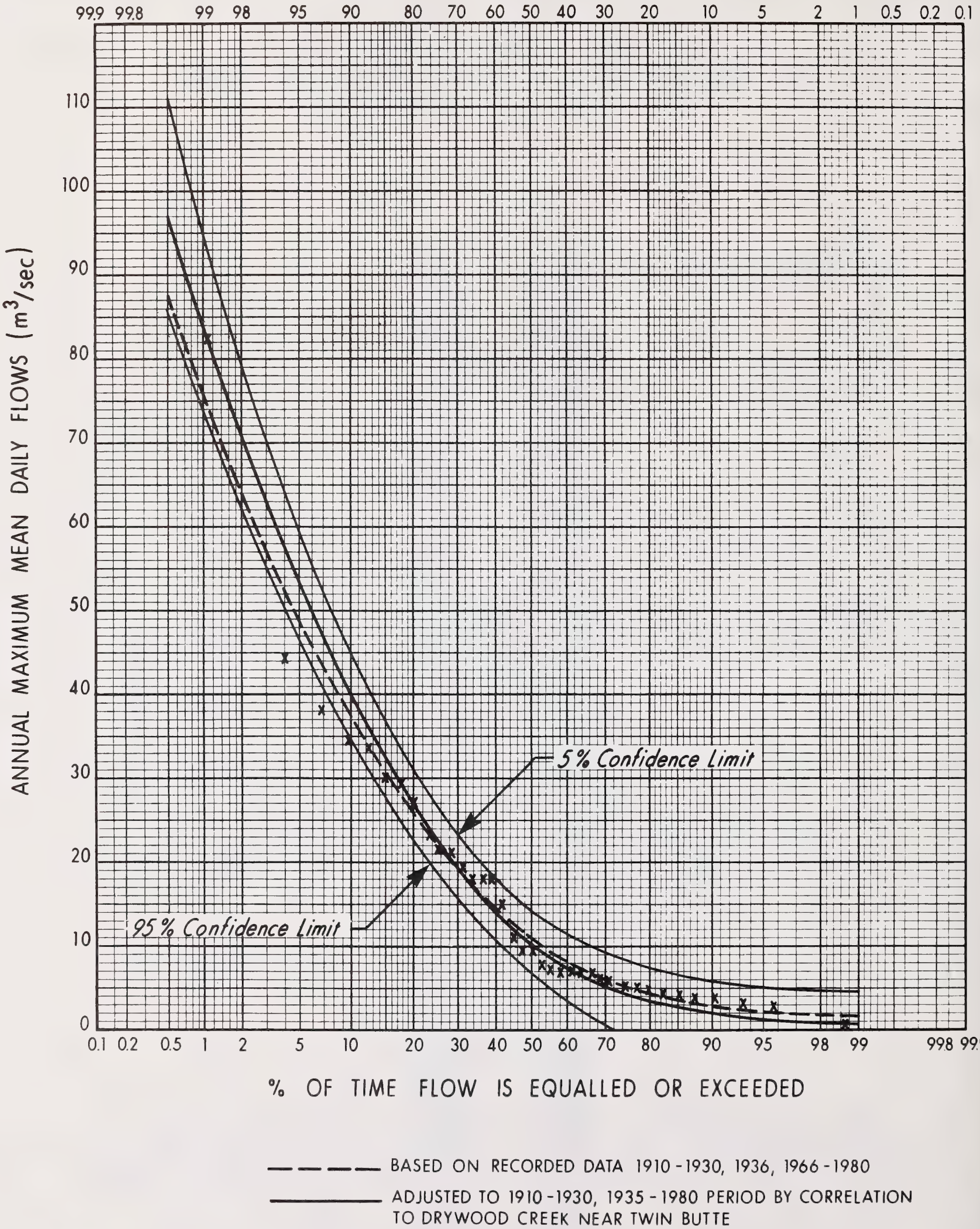


FIG. 38

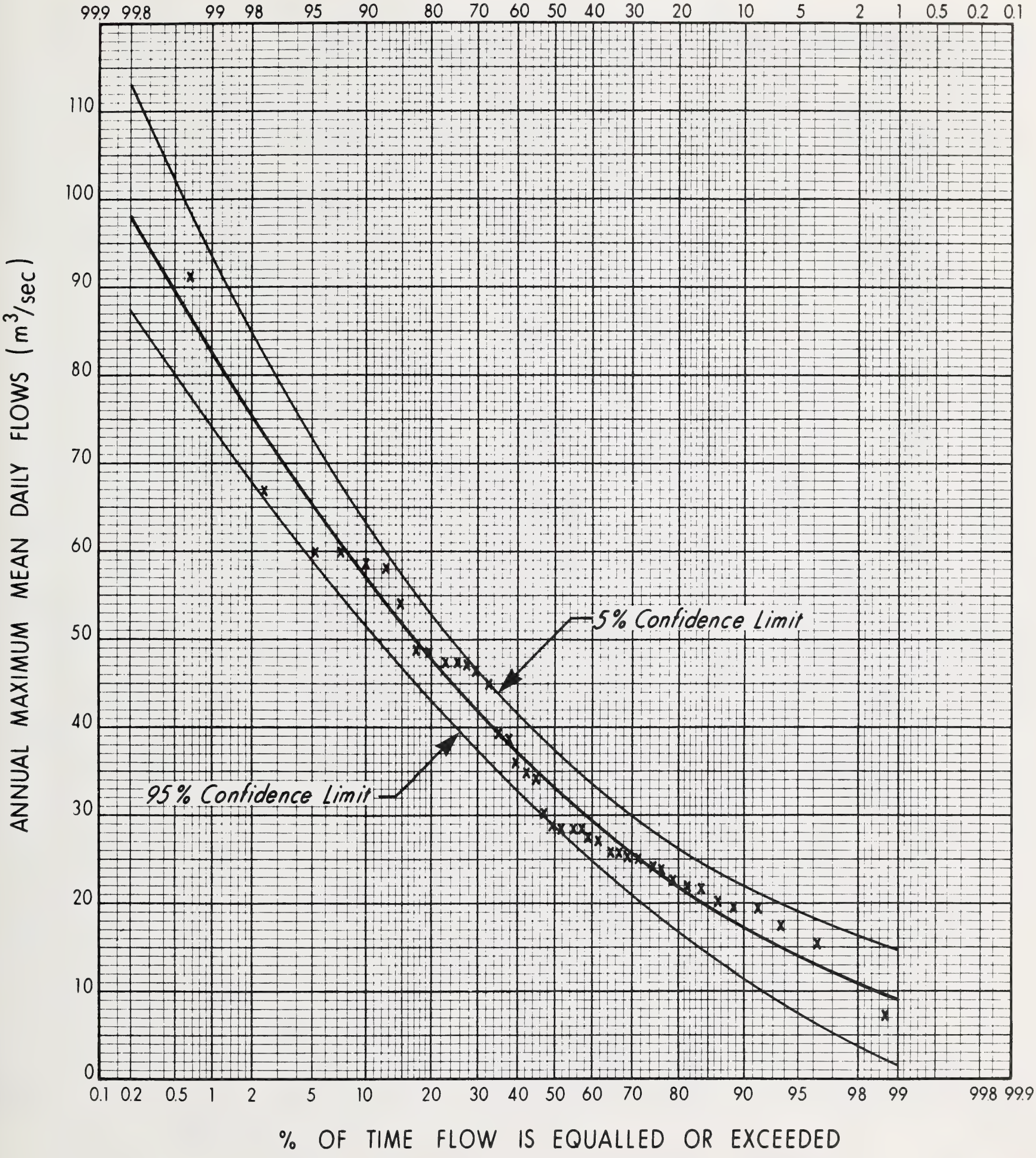


Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION HYDROLOGY BRANCH	PINCHER CREEK AT PINCHER CREEK PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 39**

MICROFILM DATE

DRAWING No.

FILE No

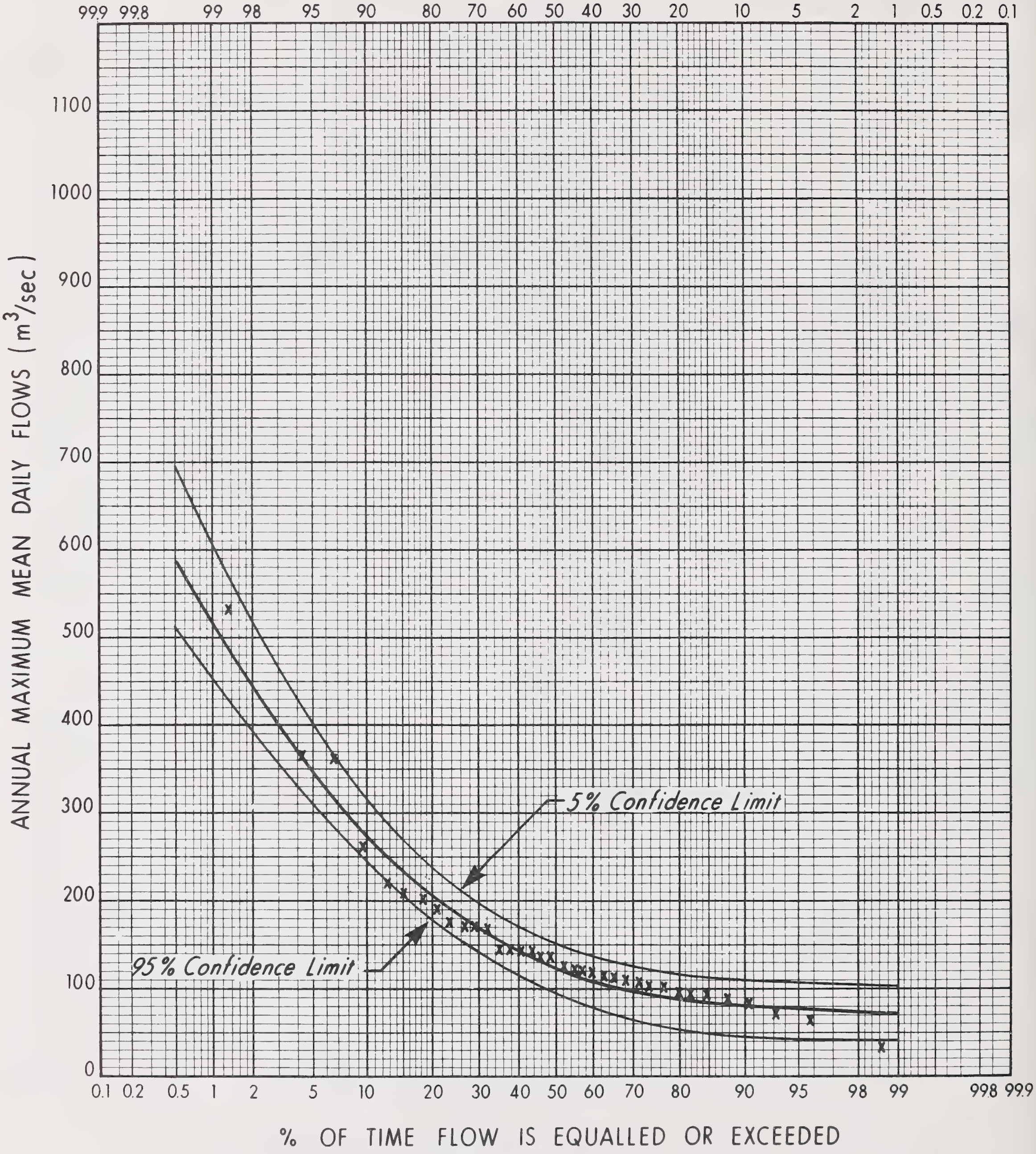


NOTE: 1923 FLOOD ASSUMED AS THE LARGEST EVENT IN THE 1908 - 1980 PERIOD

PERIOD OF RECORD 1911 - 1919, 1950 - 1980

DATA USED IN ANALYSES 1923 ESTIMATED
1911 - 1919, 1950 - 1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	CROWSNEST RIVER AT FRANK PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 40**



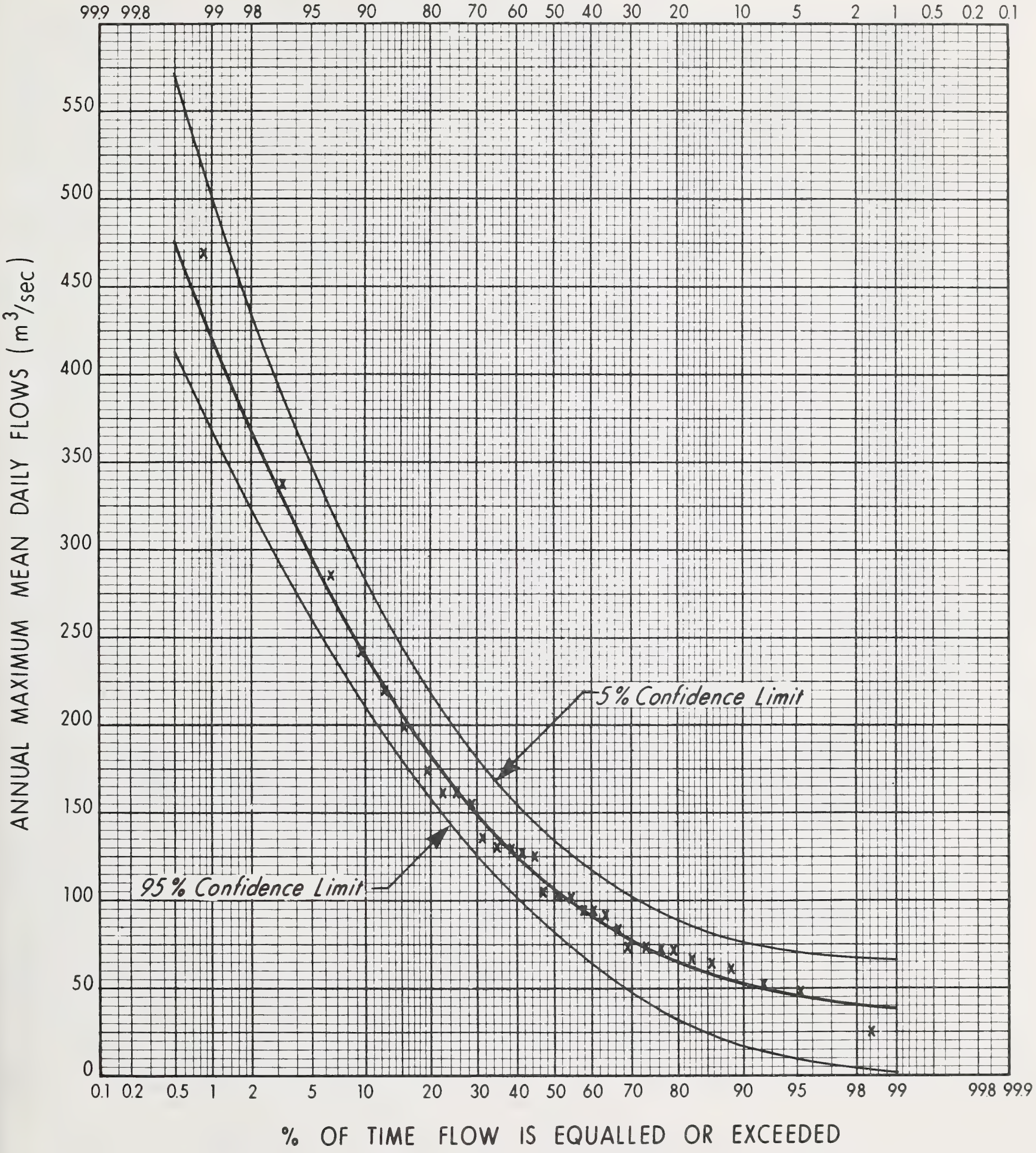
PERIOD OF RECORD 1945-1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	CASTLE RIVER NEAR BEAVER MINES PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 41**

MICROFILM DATE

DRAWING No

FILE No

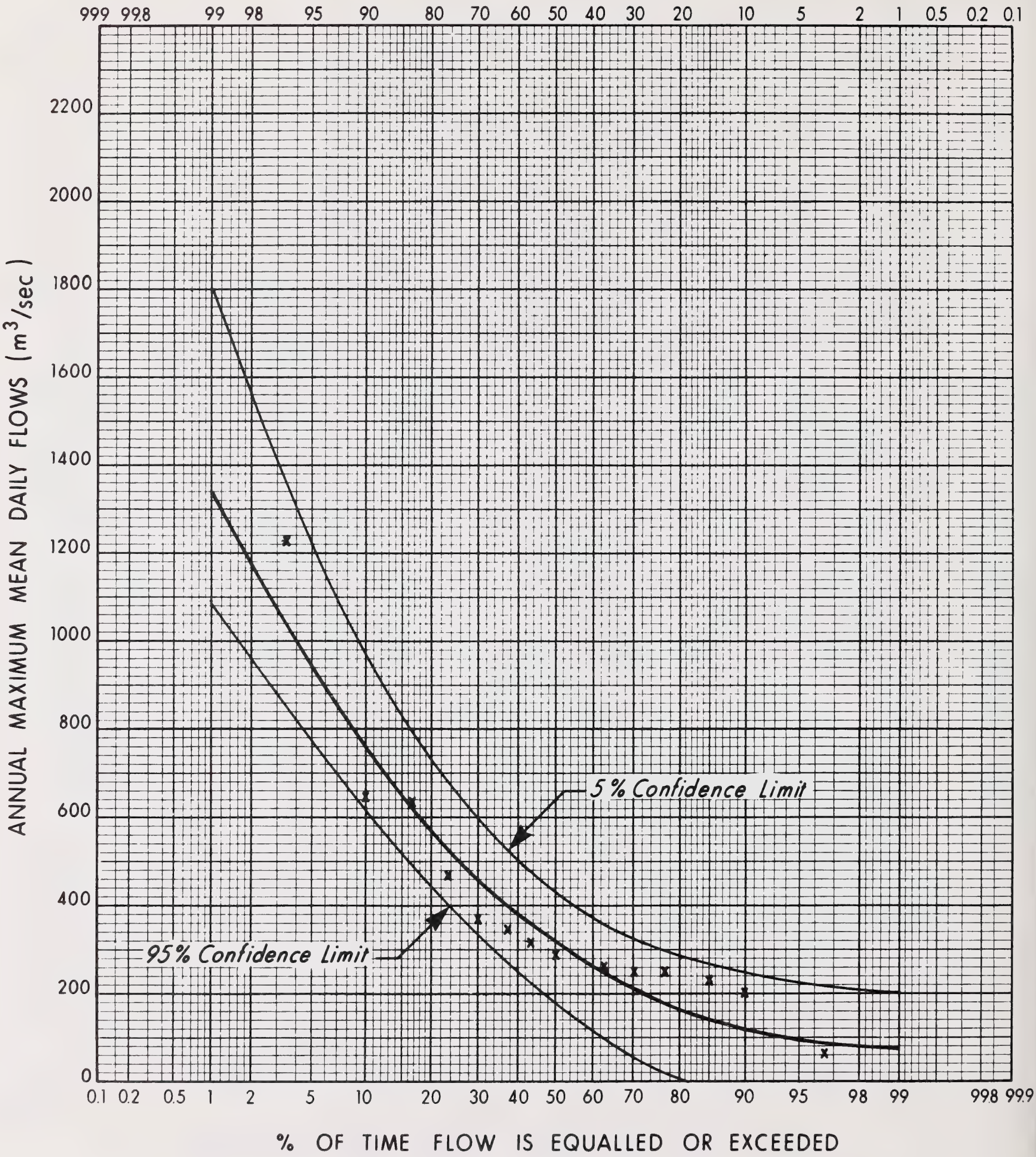


NOTE : 1923 FLOOD ASSUMED AS THE LARGEST EVENT IN THE 1923 - 1980 PERIOD

PERIOD OF RECORD 1950 - 1980

DATA USED IN ANALYSES 1923 ESTIMATED
1950 - 1980

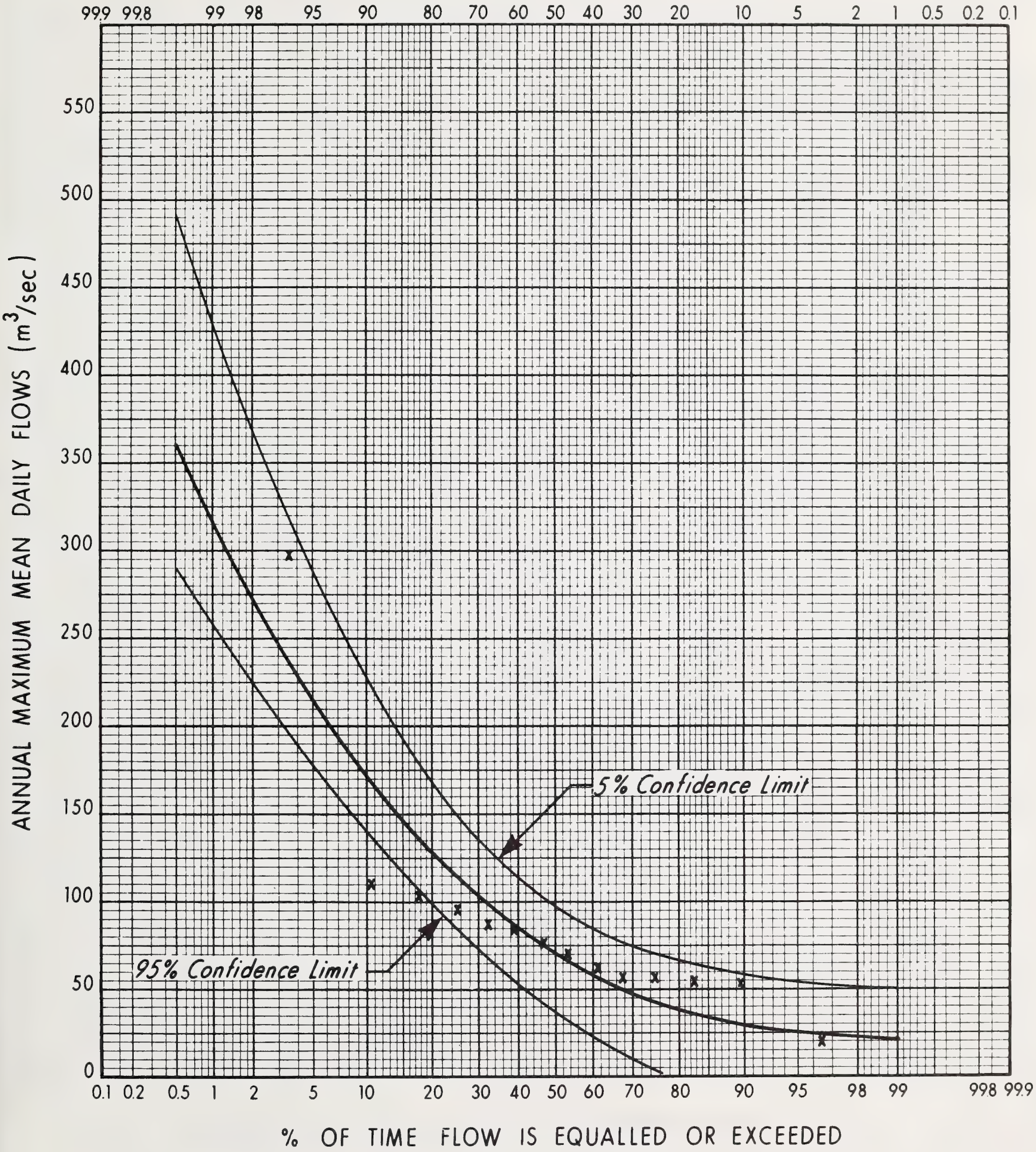
Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	OLDMAN RIVER NEAR WALDRON'S CORNER PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 42**



PERIOD OF RECORD 1966-1980

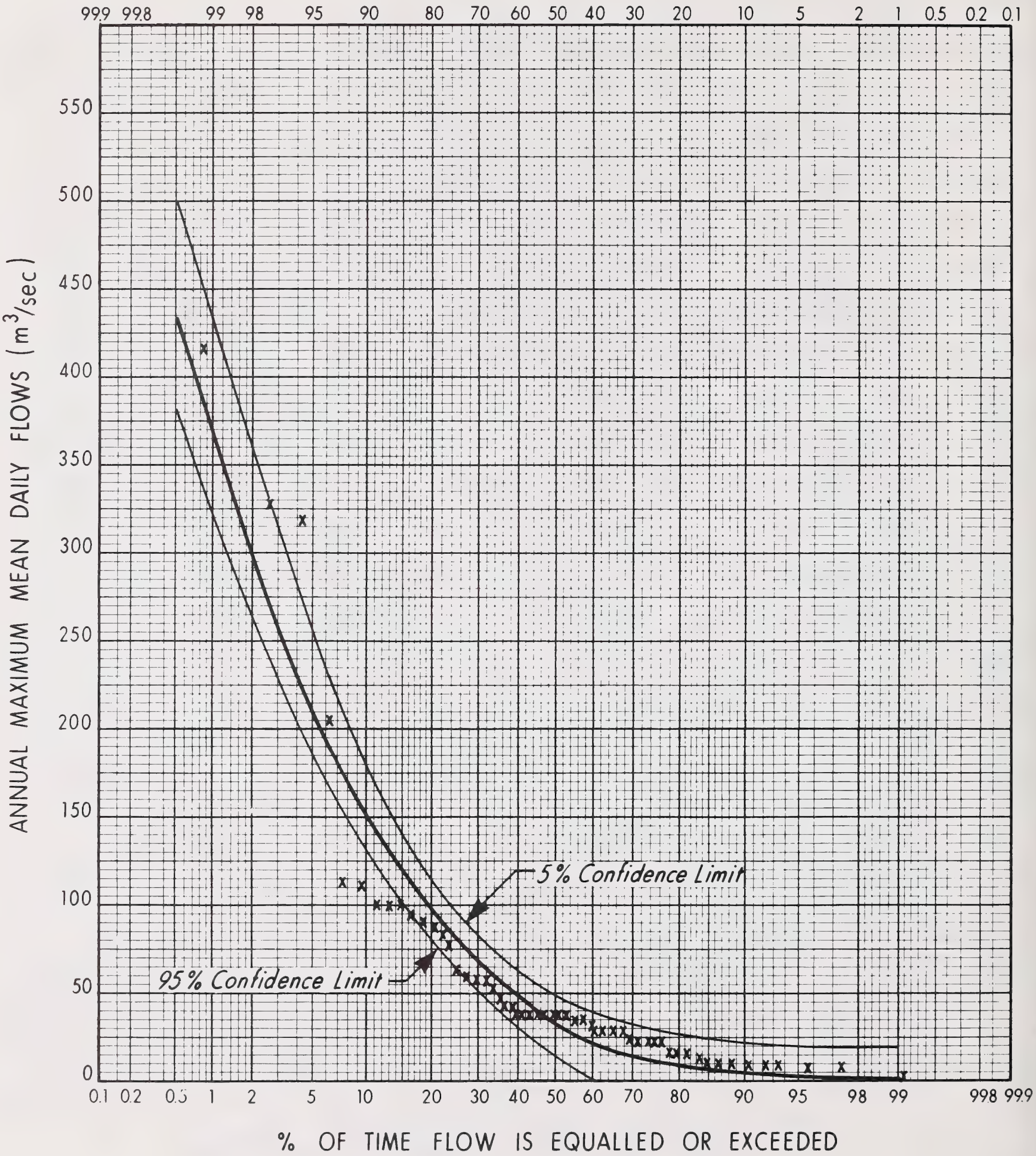
Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	OLDMAN RIVER NEAR BROCKET PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S.J.F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S.J.F.	**FIGURE No. 43**

MICROFILM DATE
DRAWING No
FILE No



PERIOD OF RECORD 1967-1980

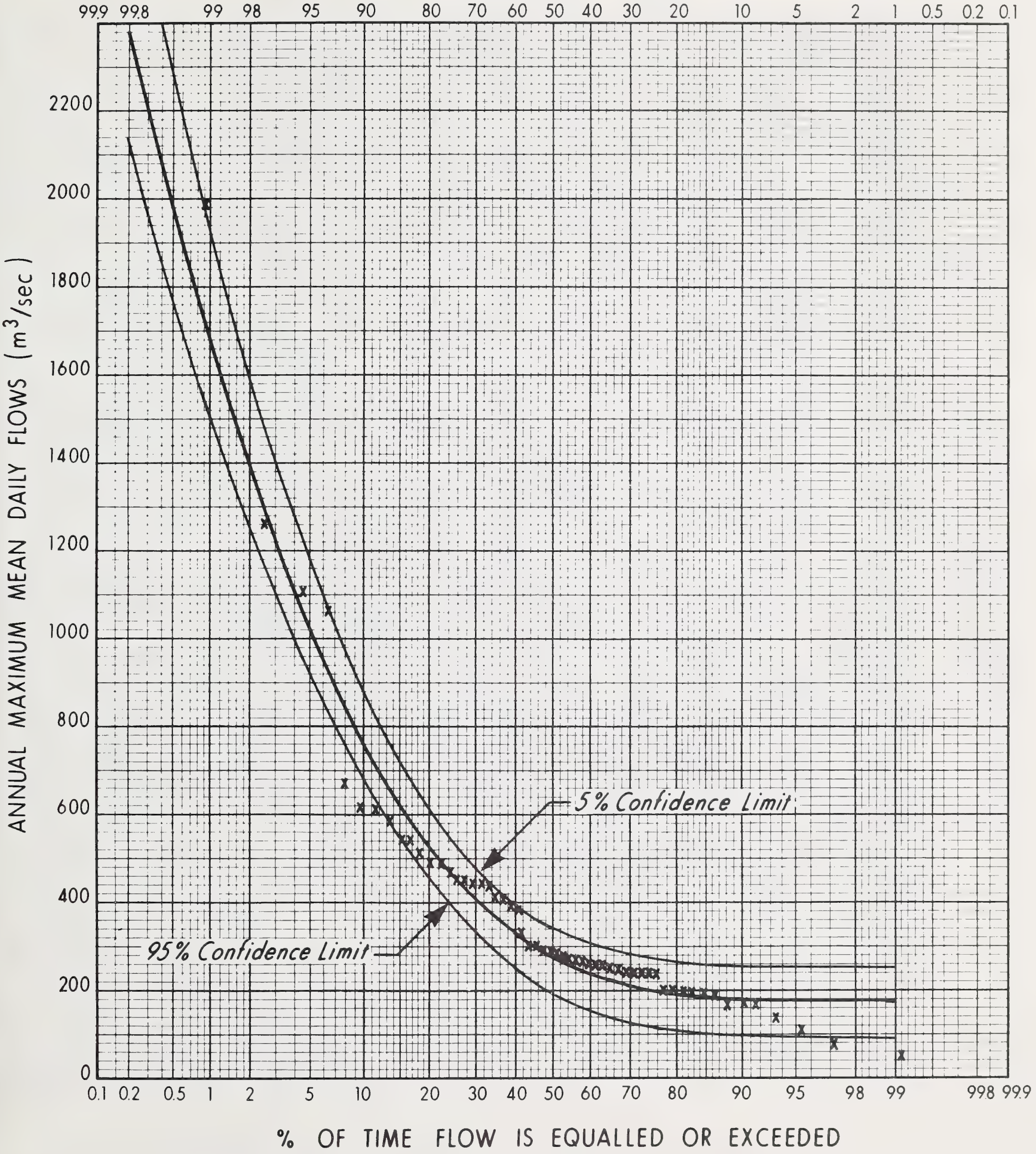
Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	CASTLE RIVER AT RANGER STATION PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 44**



NOTE : MINOR REGULATION, ENTIRE PERIOD OF RECORD ASSESSED AS HOMOGENEOUS

PERIOD OF RECORD 1910 - 1923, 1942 - 1965
1966 - 1980 REGULATED

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	WILLOW CREEK NEAR NOLAN PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F DATE AUG. 1983	DESIGNED J. AMES CHECKED	
APPROVED M. MUSTAPHA, P. ENG. DATE AUG 1982	DRAWN V. DA SILVA CHECKED S. J. F	**FIGURE No. 45**



NOTE: 1949-69 ESTIMATED AS 05AD019 (OLDMAN RIVER NEAR MONARCH) MINUS 05AB015 (WILLOW CREEK NEAR GRANUM)

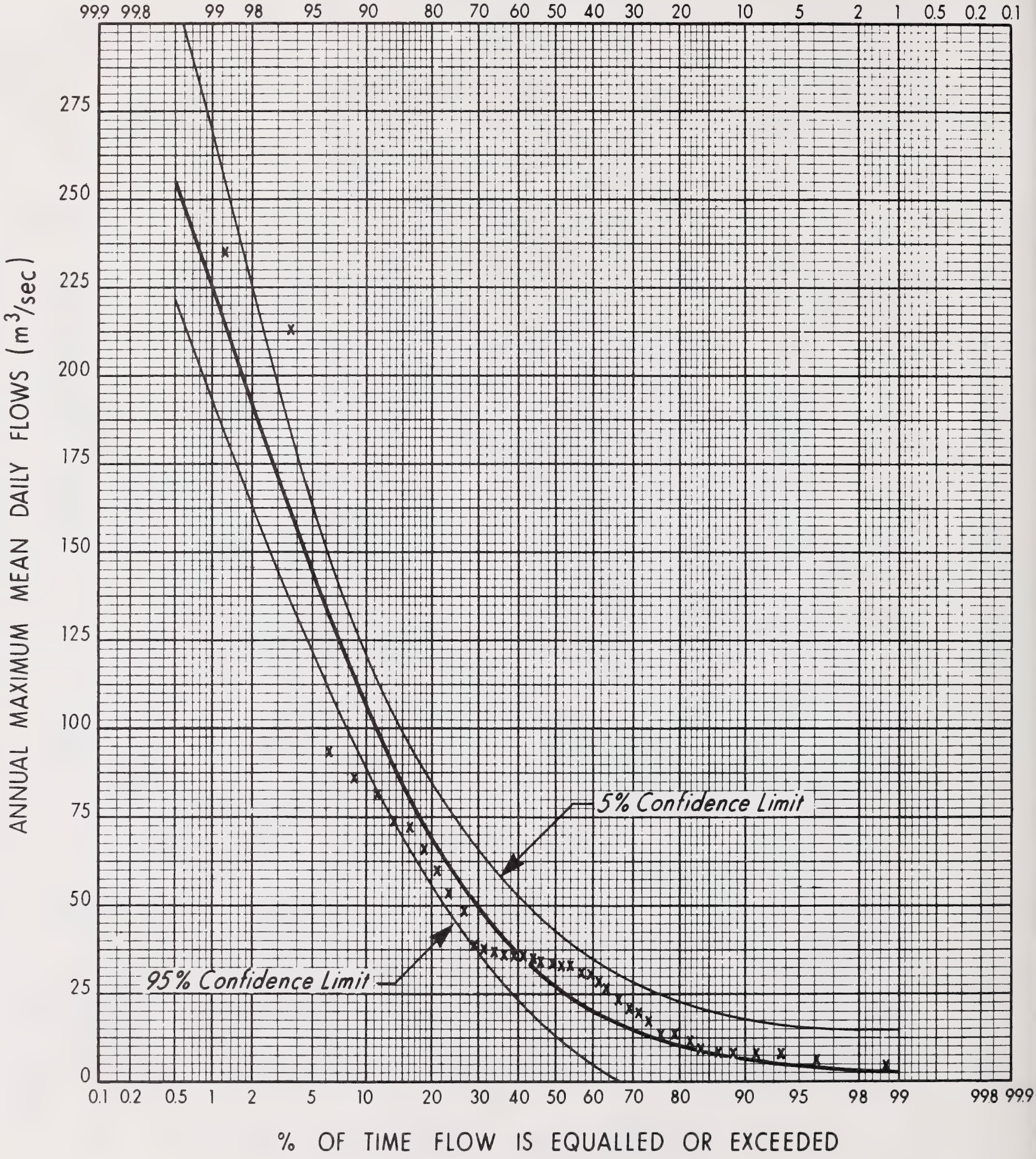
PERIOD OF RECORD 1911 - 1930, 1934 - 1948

DATA USED IN ANALYSES 1911 - 1930, 1934 - 1948
1949 - 1969 ESTIMATED

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	OLDMAN RIVER NEAR FORT MACLEOD PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT 1982	DRAWN V. DA SILVA CHECKED S. J. F	**FIGURE No. 46**

MICROFILM DATE

DRAWING No

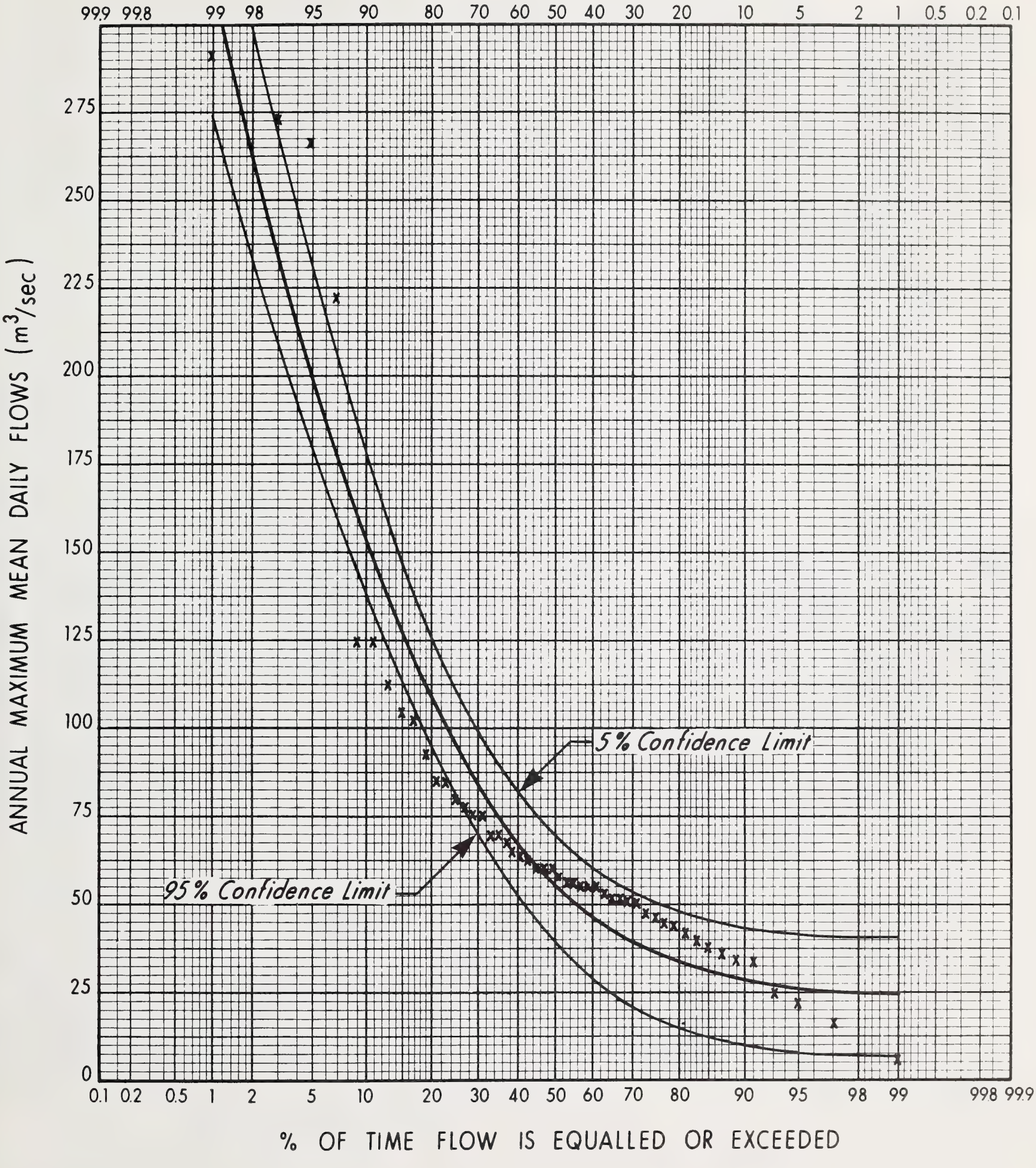


NOTE : MINOR REGULATION, ENTIRE PERIOD OF RECORD ASSESSED AS HOMOGENEOUS

PERIOD OF RECORD 1944 - 1965
1966 - 1980 REGULATED

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	WILLOW CREEK NEAR CLARESHOLM PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S J F DATE AUG 1983	DESIGNED S. J. F. CHECKED	
APPROVED M. MUSTAPHA, P. ENG. DATE AUG. 1983	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 47**

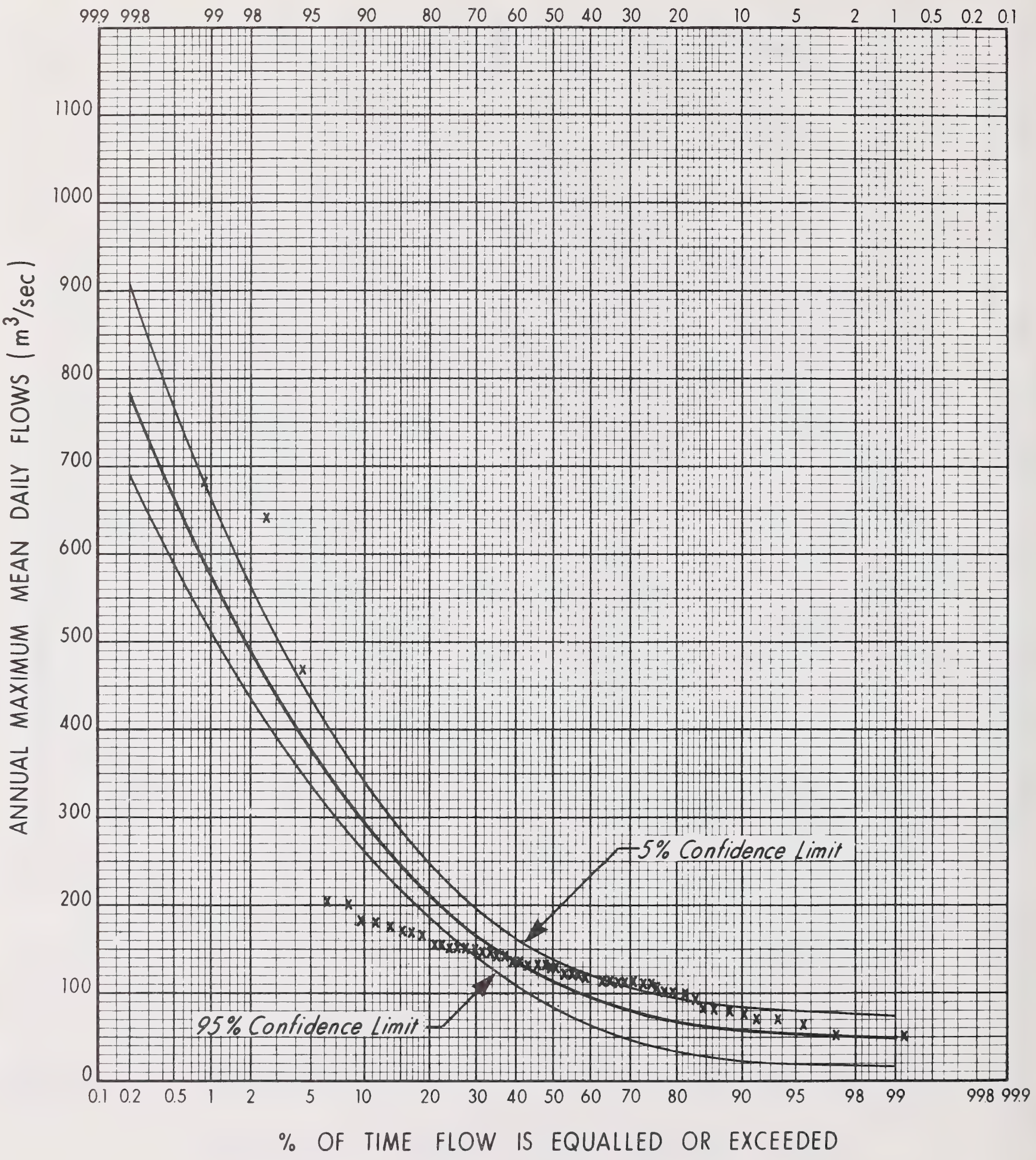
FILE No



NOTE : IRRIGATION DIVERSIONS ARE MINOR AND ARE NOT INCLUDED IN THE ANALYSIS

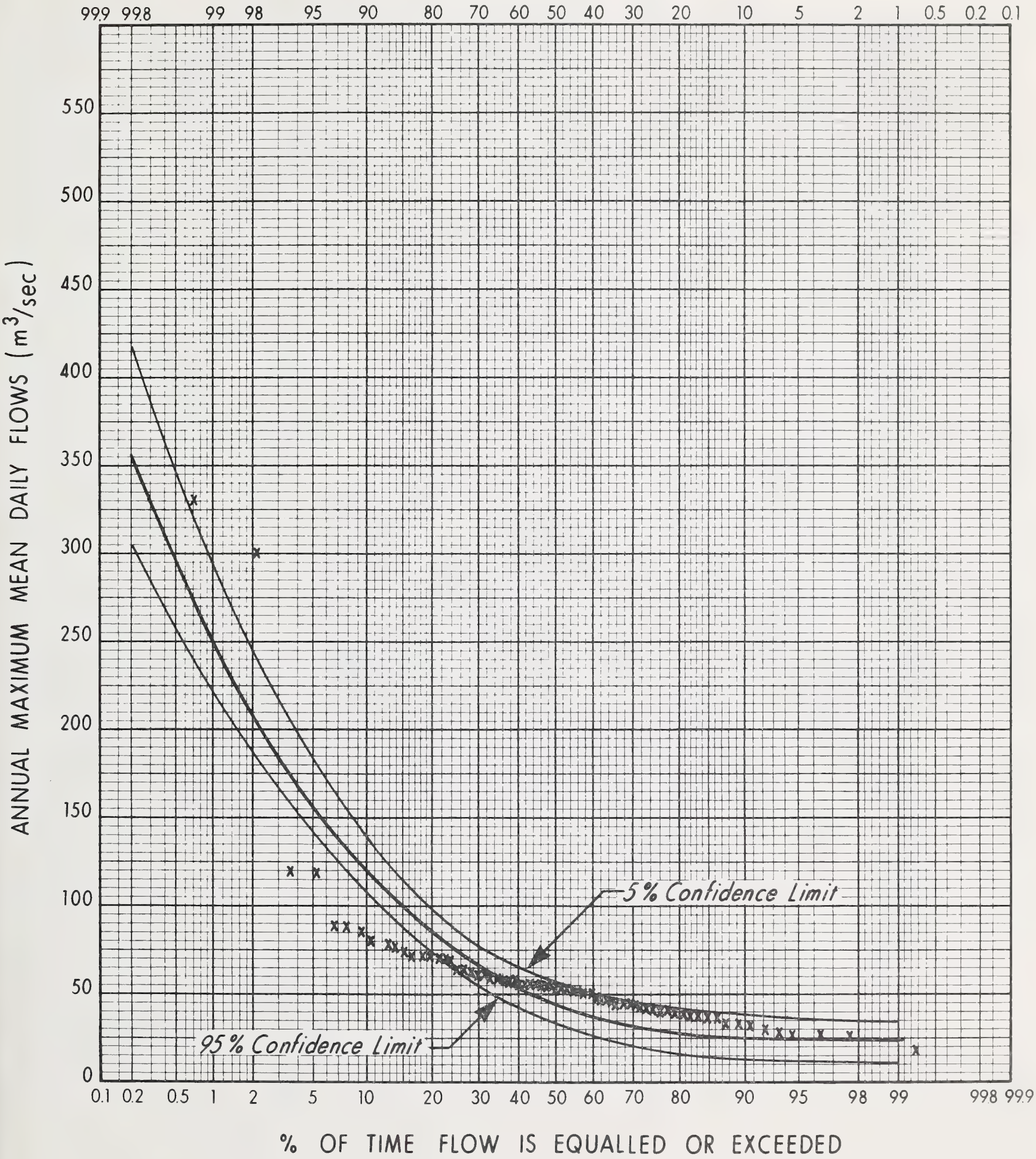
PERIOD OF RECORD 1913 - 1930, 1949 - 1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	BELLY RIVER NEAR STAND OFF PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 48**



PERIOD OF RECORD 1908 - 1930, 1948 - 1980

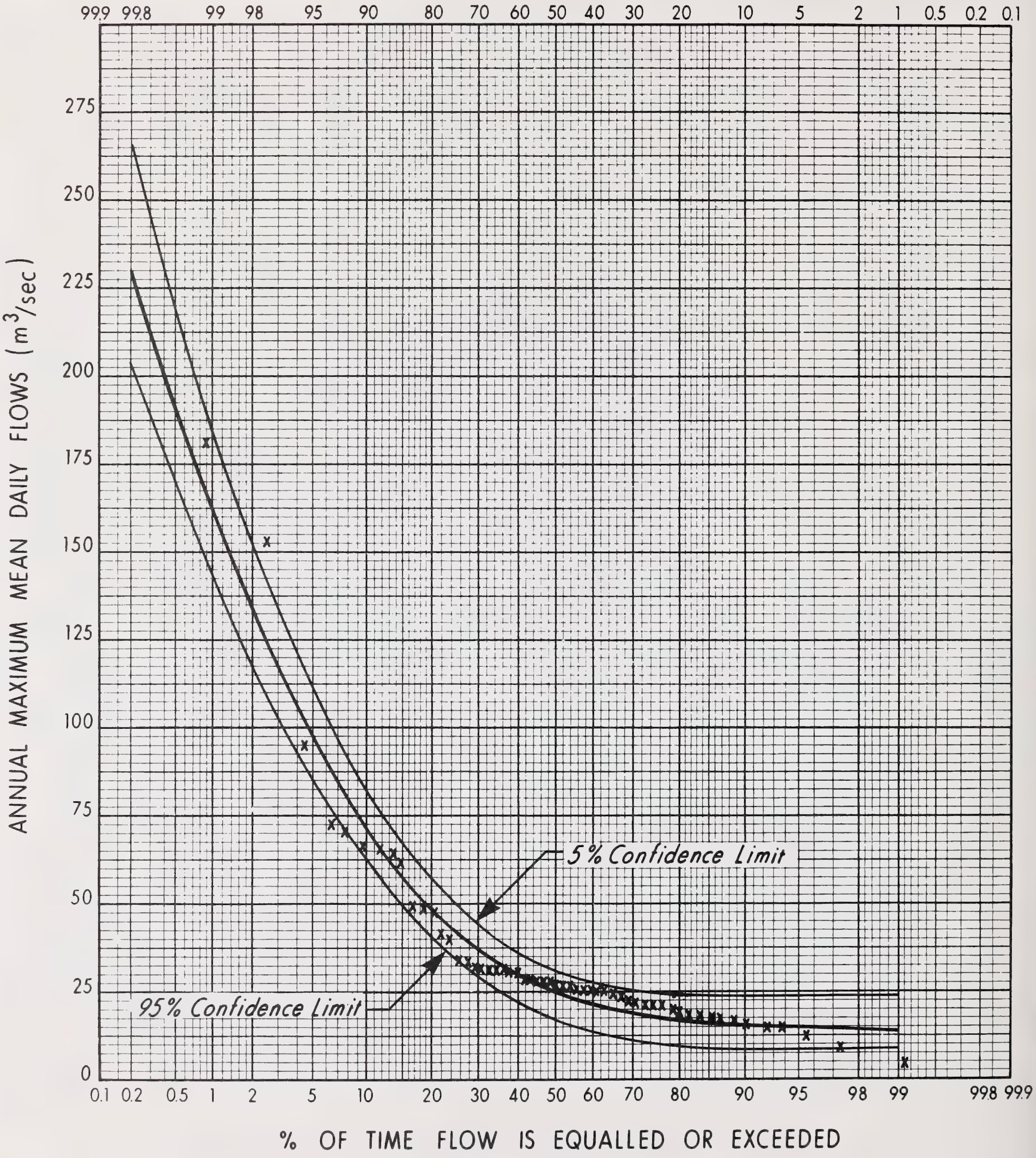
Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	WATERTON RIVER NEAR WATERTON PARK PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F DATE AUG 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 49**



NOTE: FREQUENCY IS BASED ON STATION MEAN AND STANDARD DEVIATION AND A REGIONALLY IMPLIED SKEW OF 2.70

PERIOD OF RECORD 1912 - 1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	BELLY RIVER NEAR MOUNTAIN VIEW PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 50**

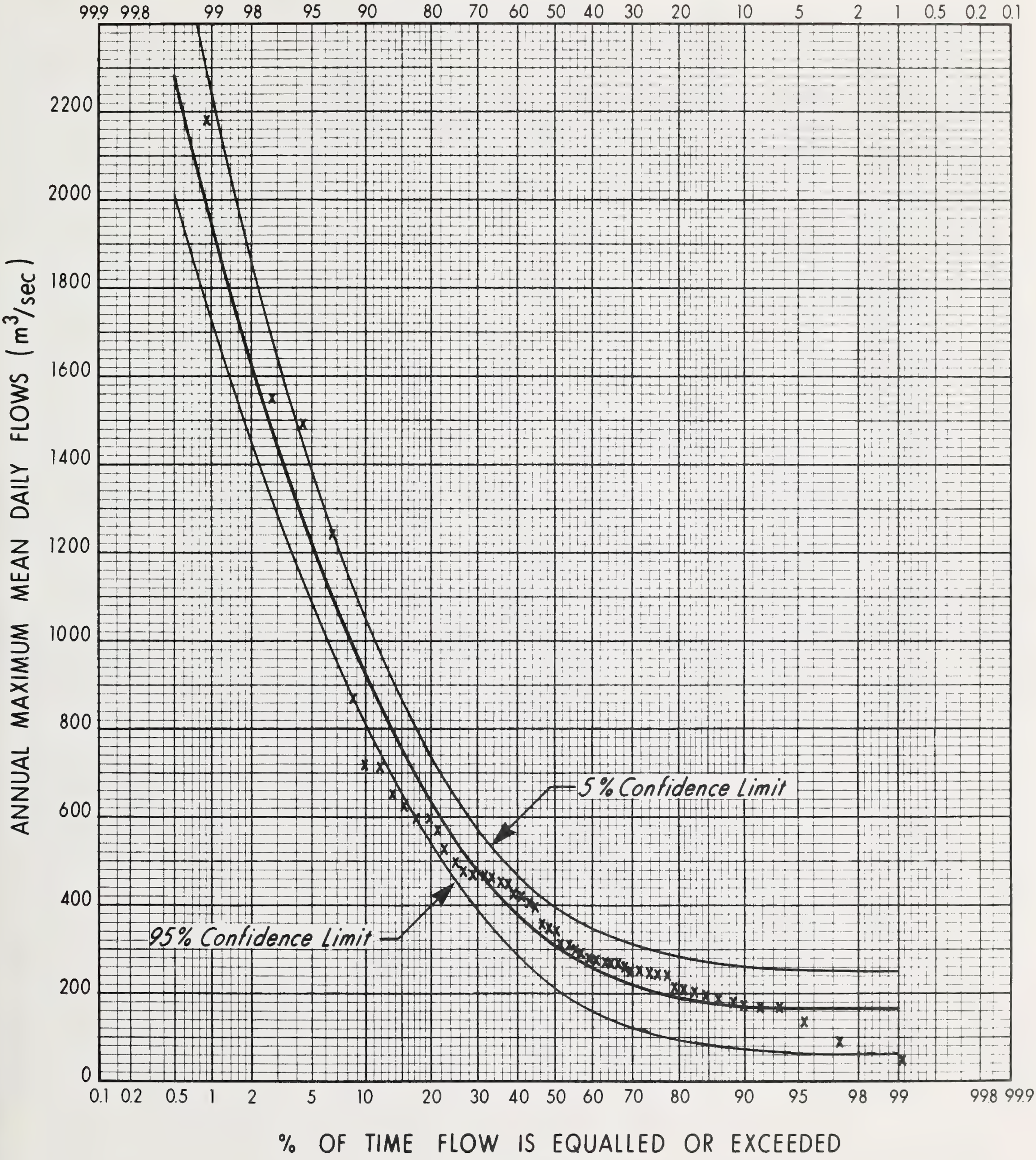


PERIOD OF RECORD 1920 - 1930, 1969 - 1980

DATA USED IN ANALYSES 1920 - 1930
1935 - 1968 ESTIMATED
1969 - 1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	DRYWOOD CREEK NEAR THE MOUTH PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 51**

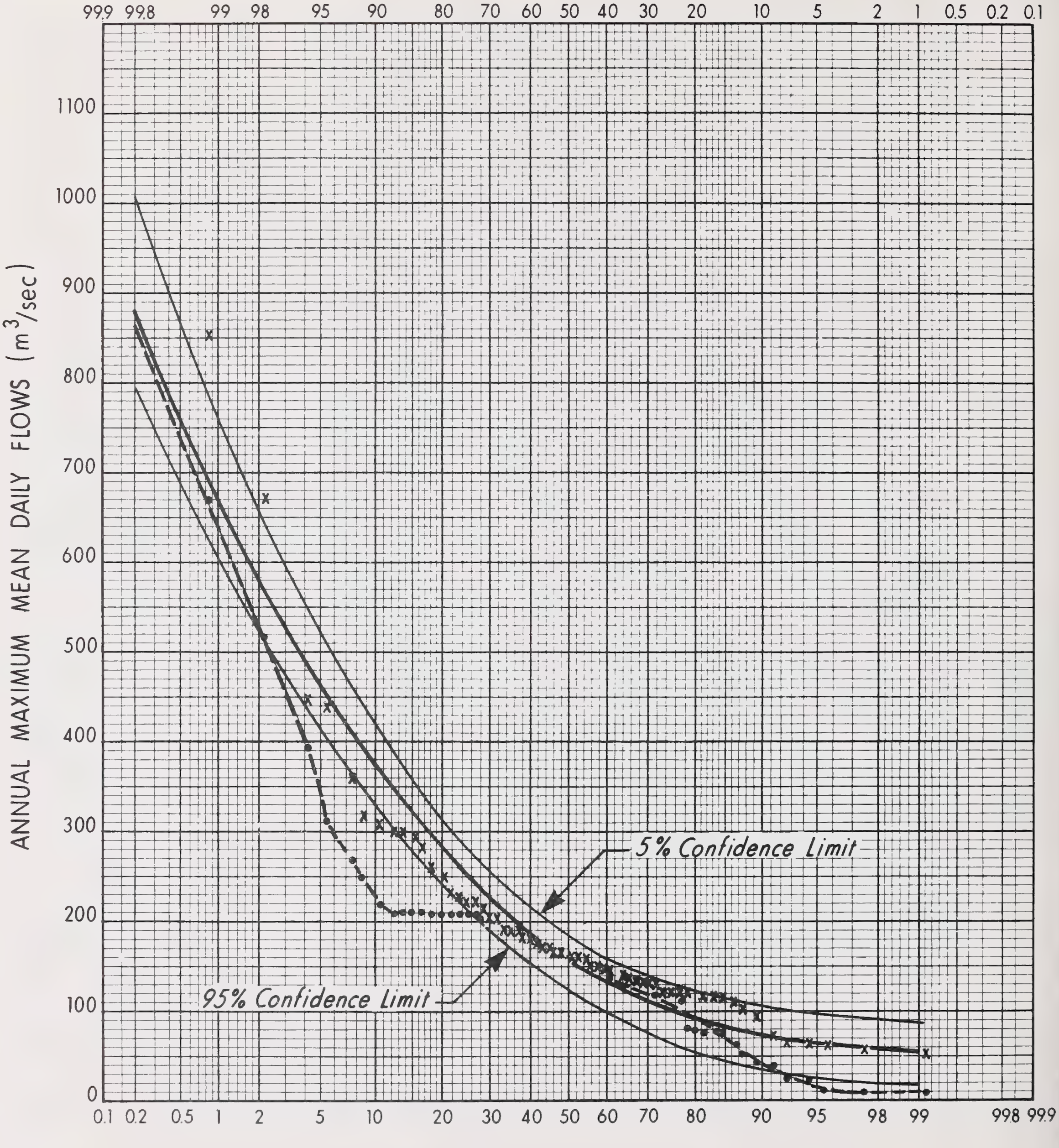
MICROFILM DATE
DRAWING No
FILE No



PERIOD OF RECORD 1949 - 1969

DATA USED IN ANALYSES 1911 - 1930 ESTIMATED
1935 - 1948 ESTIMATED
1949 - 1969

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	OLDMAN RIVER NEAR MONARCH PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 52**



NOTE: FREQUENCY CURVE FOR REGULATED CONDITIONS WAS ESTABLISHED BY JOINING THE HAZEN PLOTS. THE RECORD WAS EXTENDED TO INCLUDE THE 1916-1930, 1935-1966 PERIOD BY A DIRECT TRANSFER OF DATA FROM STATION 5AD08 (WATERTON RIVER NEAR STAND OFF

PERIOD OF RECORD 1916-1930, 1935-1981

——— NATURAL

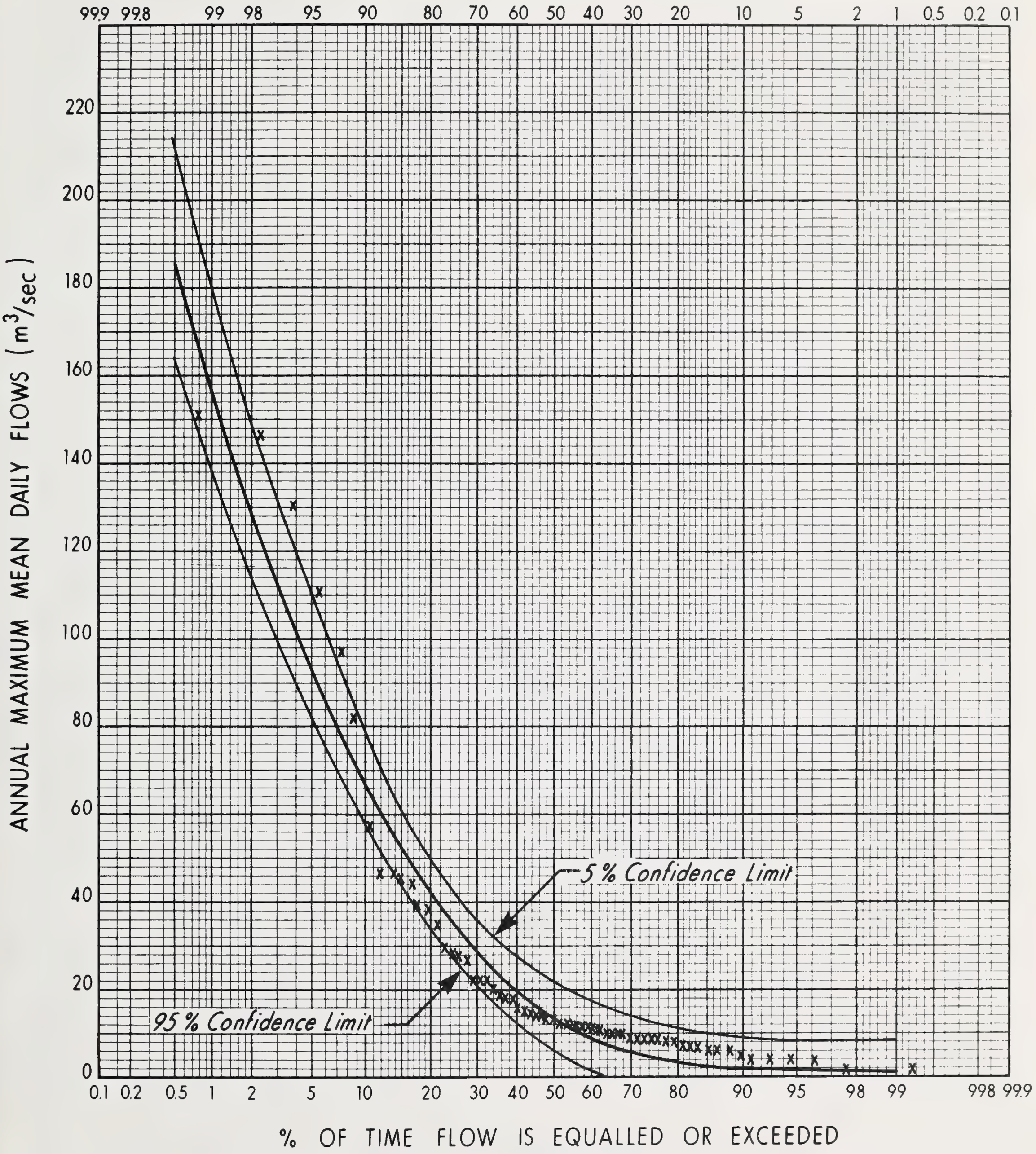
— — — — REGULATED

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	WATERTON RIVER AT GLENWOOD PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED S. J. F. CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 53**

MICROFILM DATE

DRAWING No

FILE No

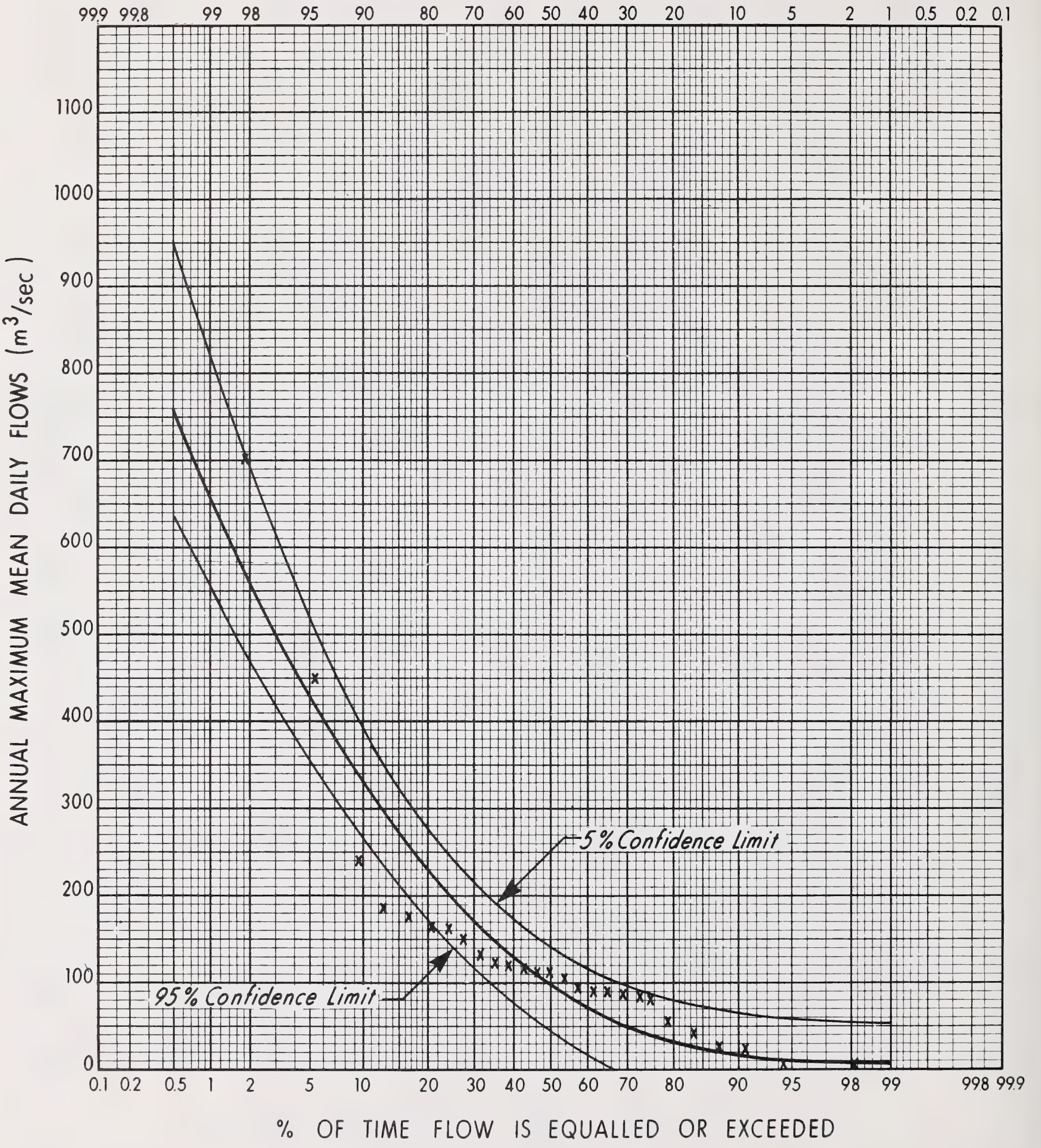


PERIOD OF RECORD 1910 - 1911, 1913, 1914
1920 - 1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	LEE CREEK AT CARDSTON PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 54**

MICROFILM DATE

DRAWING No.



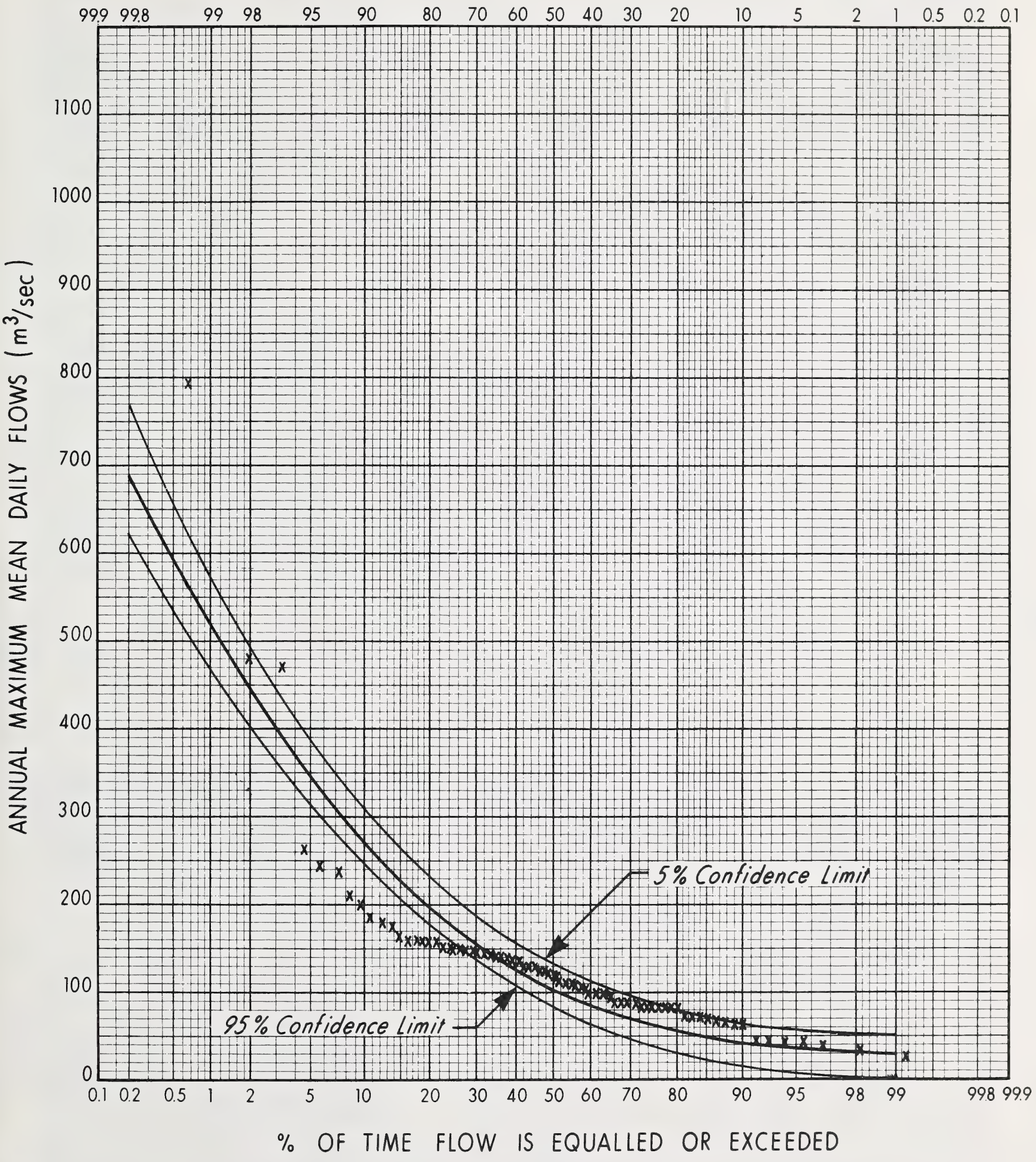
NOTE : POST REGULATION REFERS TO THE PERIOD FOLLOWING THE CONSTRUCTION OF ST. MARY RESERVOIR

PERIOD OF RECORD 1912 - 1980

DATA USED IN THE ANALYSES 1954 - 1980

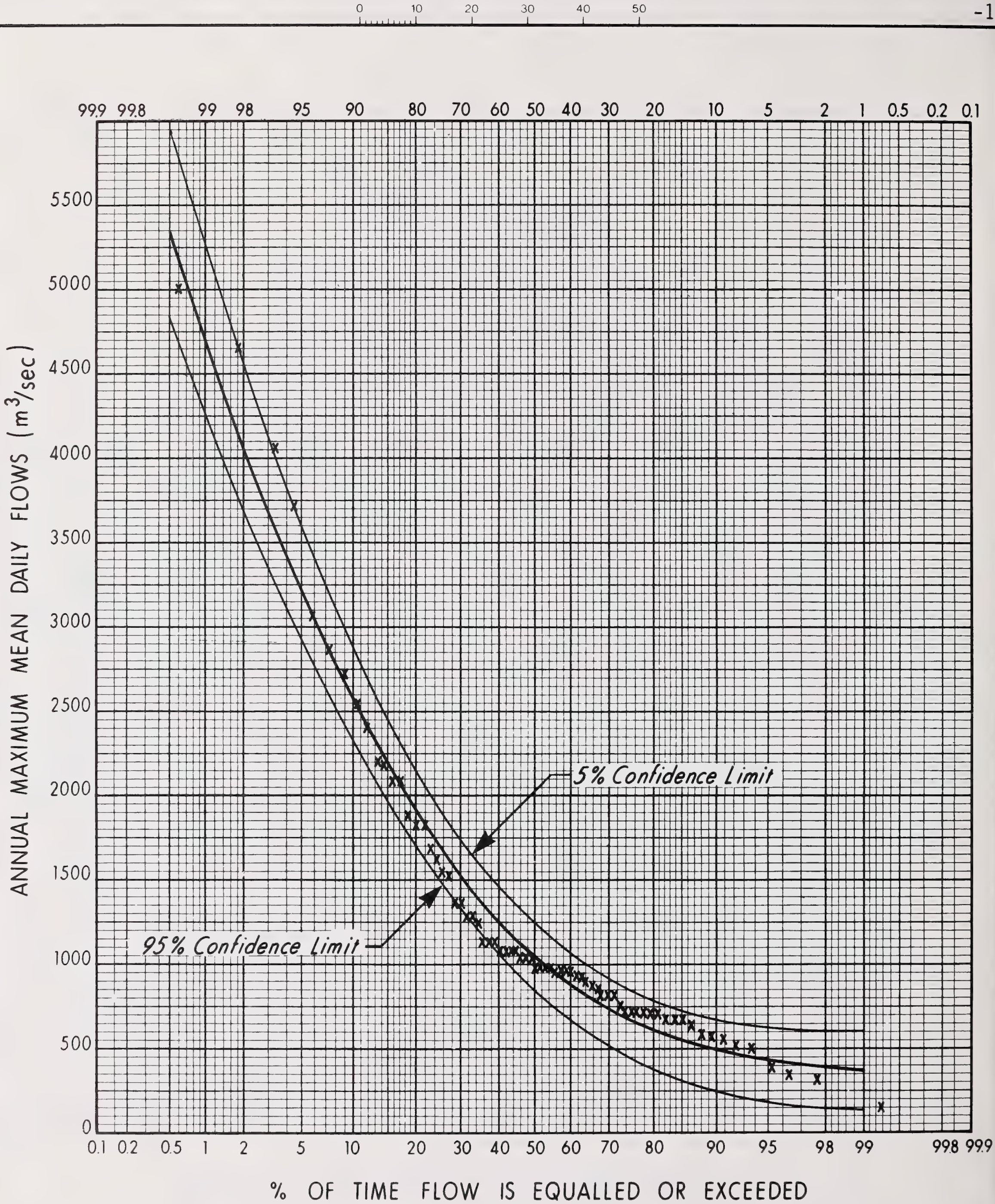
Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	ST. MARY RIVER NEAR LETHBRIDGE PEARSON III FREQUENCY DISTRIBUTION OF POST REGULATION (ST. MARY DAM) ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 55**

FILE No.



PERIOD OF RECORD 1903 - 1980 REGULATED

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	ST. MARY RIVER AT INTERNATIONAL BOUNDARY PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F. DATE AUG. 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUGT. 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 56**



NOTE: RECORD OF FLOOD PEAKS ASSUMED STATIONARY IN SPITE OF VARYING DEGREES OF UPSTREAM REGULATION (BOTHE 1981)

PERIOD OF RECORD 1902, 1908, 1911 - 1933, 1935 - 1980

Alberta ENVIRONMENT	TECHNICAL SERVICES DIVISION **HYDROLOGY BRANCH**	SOUTH SASKATCHEWAN AT MEDICINE HAT PEARSON III FREQUENCY DISTRIBUTION OF ANNUAL MAXIMUM MEAN DAILY FLOWS
SUBMITTED S. J. F DATE AUG 1982	DESIGNED J. AMES CHECKED	
APPROVED J. CARD DATE AUG 1982	DRAWN V. DA SILVA CHECKED S. J. F.	**FIGURE No. 57**

MICROFILM DATE
DRAWING No.
FILE No

Figure 58: Flood of May 1902, looking downstream on the Oldman River (previously called the Belly River) near Lethbridge, possibly the location of the present day highway bridges. (Photo from The Archives, Sir Alexander Galt Museum, City of Lethbridge)

Figure 59: Flood of May 1902, Oldman River near Lethbridge. Approximate site of present day railway bridge. (Photo from The Archives, Sir Alexander Galt Museum, City of Lethbridge)

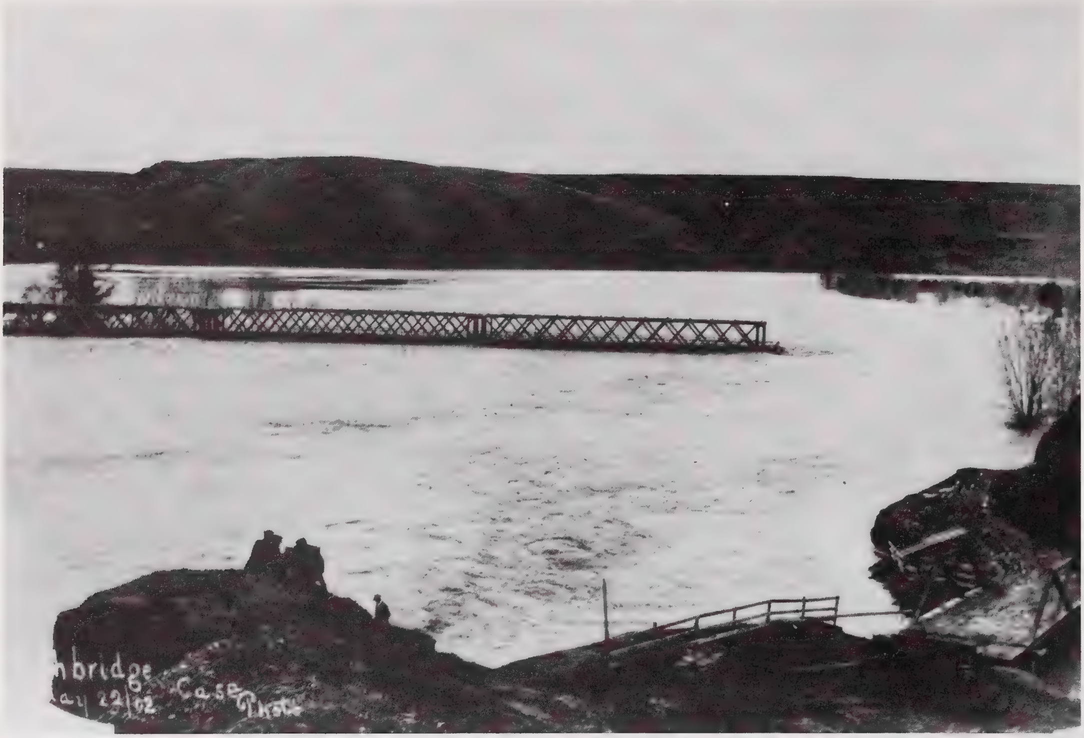


Figure 60: Flooding, Oldman River near Lethbridge, May 22, 1902. Photo taken on east sid of river valley just upstream of present day storm sewer outlet, which is approximately 2 feet upstream of old bridge piers, which are still visible and 600 feet downstream of the new HWY #3 bridge. (Photo from the Archives, Sir Alexander Galt Museum, City of Lethbridg

Figure 61: Oldman River near Lethbridge, flood of June 1908. The area shown is close to t present C.P.R. High Level bridge. (Photo from The Archives, Sir Alexander Galt Museum, Ci of Lethbridge).

Figure 62: Flood on Oldman River near Lethbridge, June 10, 1953. (Photo by N.E. Kloppenborg, Canada Agriculture, Research Station, Lethbridge)

Figure 63: Flood on Oldman River near Lethbridge, June 10, 1953. (Photo by N.E. Kloppenborg, Canada Agriculture, Research Station, Lethbridge)

Figure 64: Highway No. 3 bridge on Oldman River at Lethbridge, June 1953 flood.

Figure 65: Highway No. 3 Bridge on Oldman River at Lethbridge, June 1953 flood.

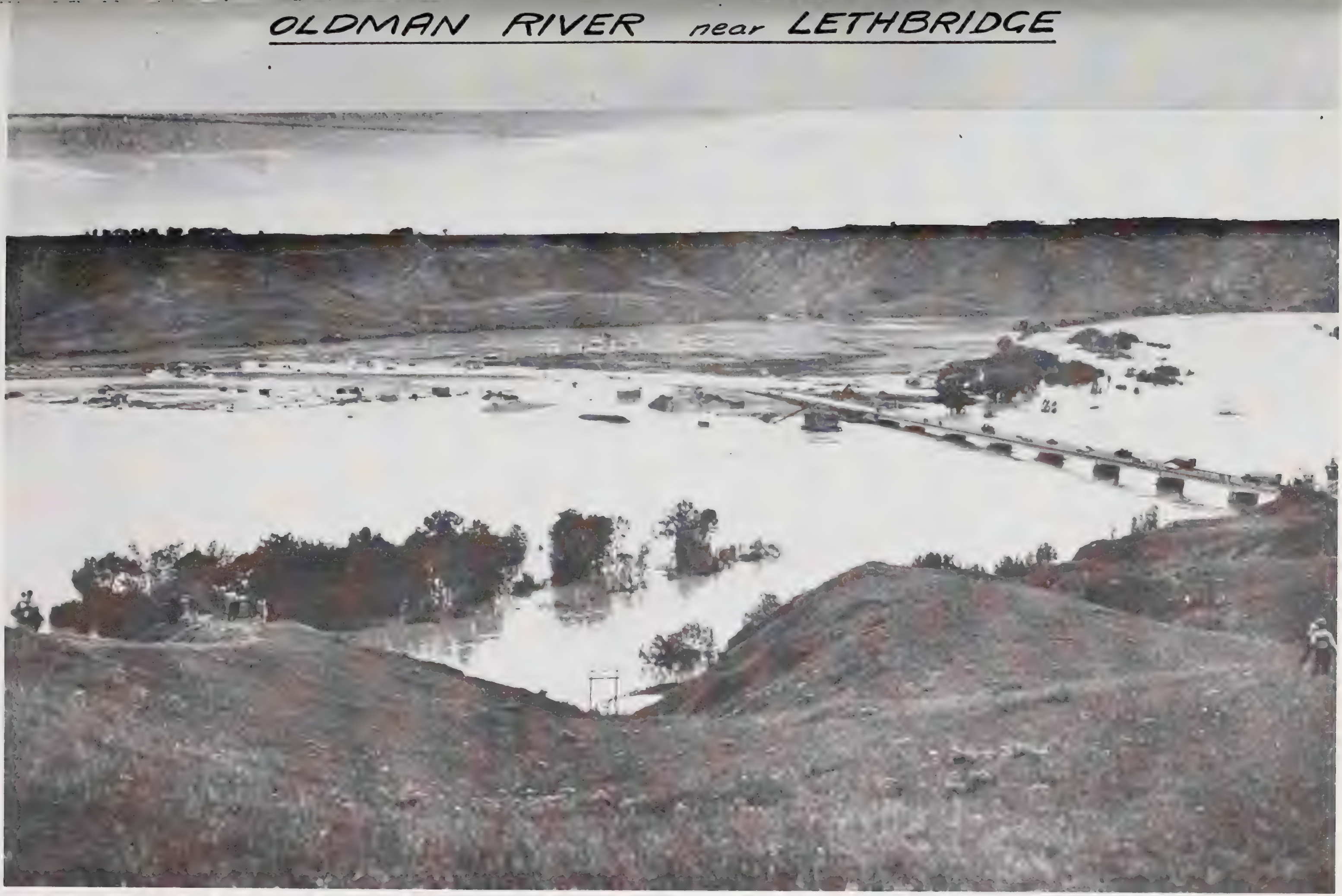


Figure 66: Traffic Bridge over Oldman River on Highway No. 3 at western entrance to Lethbridge, evening of June 9, 1953. (Lethbridge Herald Photograph)

Figure 67: Flood waters spreading into the plant of the Lethbridge Sand and Gravel Company, evening of June 9, 1953. Plant can be seen in left background of photograph 66. (Lethbridge Herald Photograph)

Figure 69: Aerial photograph looking upstream towards C.P.R. trestle bridge. Gravel plant in right foreground. Probably taken on June 10, 1953. (Calgary Herald Photograph)

Figure 70: Flood waters from farm buildings on outskirts of Pincher Creek, June 1953 (Calgary Herald Photograph)

Figure 71: Oldman River near MacLeod, Water over Highway No. 2 on right bank (town side) of bridge, June 1953. (Calgary Herald Photograph)

Figure 72: South Saskatchewan River at Medicine Hat, Aerial view of flooded area at junction of Ross and Seven Persons Creeks with South Saskatchewan River. Looking N.W., June 11, 1953.

Figure 73: Flooded Athletic Park. Looking north across South Saskatchewan River at Medicine Hat, June 11, 1953. (Calgary Herald Photograph)

Figure 74: Flooding at Waterton Park, June 1964. (P.F.R.A. photo)

Figure 75: Flooding at Waterton Park, June 1964. (P.F.R.A. photo)

Figure 76: Flooding at Waterton Park, June 1964. (P.F.R.A. photo)

Figure 77: Flooding at Waterton Park, June 1964. (P.F.R.A. photo)

Figure 78: Ice Jam - Taber Provincial Park, March 1972. (Photo by Alberta Recreation and Parks, Southern Region)

Figure 79: Ice Jam - Taber Provincial Park, March 1972. (Photo by Alberta Recreation and Parks, Southern Region)

Figure 80: Flooding on St. Mary River, June 20, 1975. (Water Survey of Canada photo)

Figure 81: Flooding on Belly River near Standoff, June 20, 1975. (Water Survey of Canada photo)

Figure 82: Flooding on Lee Creek near Cardston, June 20, 1975. (Water Survey of Canada photo)

Figure 83: Flooding on Lee Creek at Cardston, June 20, 1975. (Water Survey of Canada photo)

Figure 84: Flooding on Belly River near Standoff, June 20, 1975. (Water Survey of Canada photo)

Figure 85: Flooding on Lee Creek at Cardston, June 20, 1975. (Water Survey of Canada photo

Figure 86: Flooding on St. Mary River at bridge crossing about 8 kilometers upstream of confluence with Oldman River, June 20, 1975. (Water Survey of Canada photo)

Figure 87: Flooding at Waterton townsite campground, June 20, 1975. (Alberta Environment photo)

Figure 88: Flooding at Waterton Park, June 20, 1975. (Water Survey of Canada photo)

Figure 89: Flood damage on Belly River near Mountain View, June 20, 1975. A fallen cablewa
is all that remains of the Water Survey of Canada gauging station. (Water Survey of Canada
photo)

Figure 90: Erosion damage along Pincher Creek, June 20, 1975. Flood waters eroded a new channel across a large meander loop. (Water Survey of Canada photo)

Figure 91: June 1964 Flood at Cardston. (photo by Del Steed)

Figure 92: June 1964 Flood at Cardston. (photo by Del Steed)

Figure 93: Lee Creek at Cardston - Flood of June 1964. (photo by Del Steed)

Figure 94: Waterton Park, 300 metres below Cameron falls, June 9, 1964. (photo by Dick Allison)

Figure 95: Waterton Park, June 9, 1964. About 500 metres below Cameron Falls. (photo by Dick Allison)

Figure 96: Waterton Park Flood on June 9, 1964. (photo by Dick Allison)

Figure 97: Lake front cabin, Waterton Park, June 9, 1964. (photo by Dick Allison)

Figure 98: Waterton Park - Main Street, June 9, 1964. (photo by Dick Allison)

Figure 99: Waterton Park, South End of Main Street, June 9, 1964. (photo by Dick Allison)

Figure 100: Waterton Park. Cabins on the south end of Main Street, June 9, 1964. (photo by Dick Allison)

Figure 101: Lee Creek at Cardston, June 20, 1975.

Figure 102: Lee Creek at Cardston, June 20, 1975.

Figure 103: Flooding on Lee Creek at Cardston, June 20, 1975.

Figure 104: Flooding at Cardston, June 20, 1975.

Figure 105: Oldman River at the Lethbridge Northern Irrigation District Weir, at 3:15 p.m., June 20, 1975.

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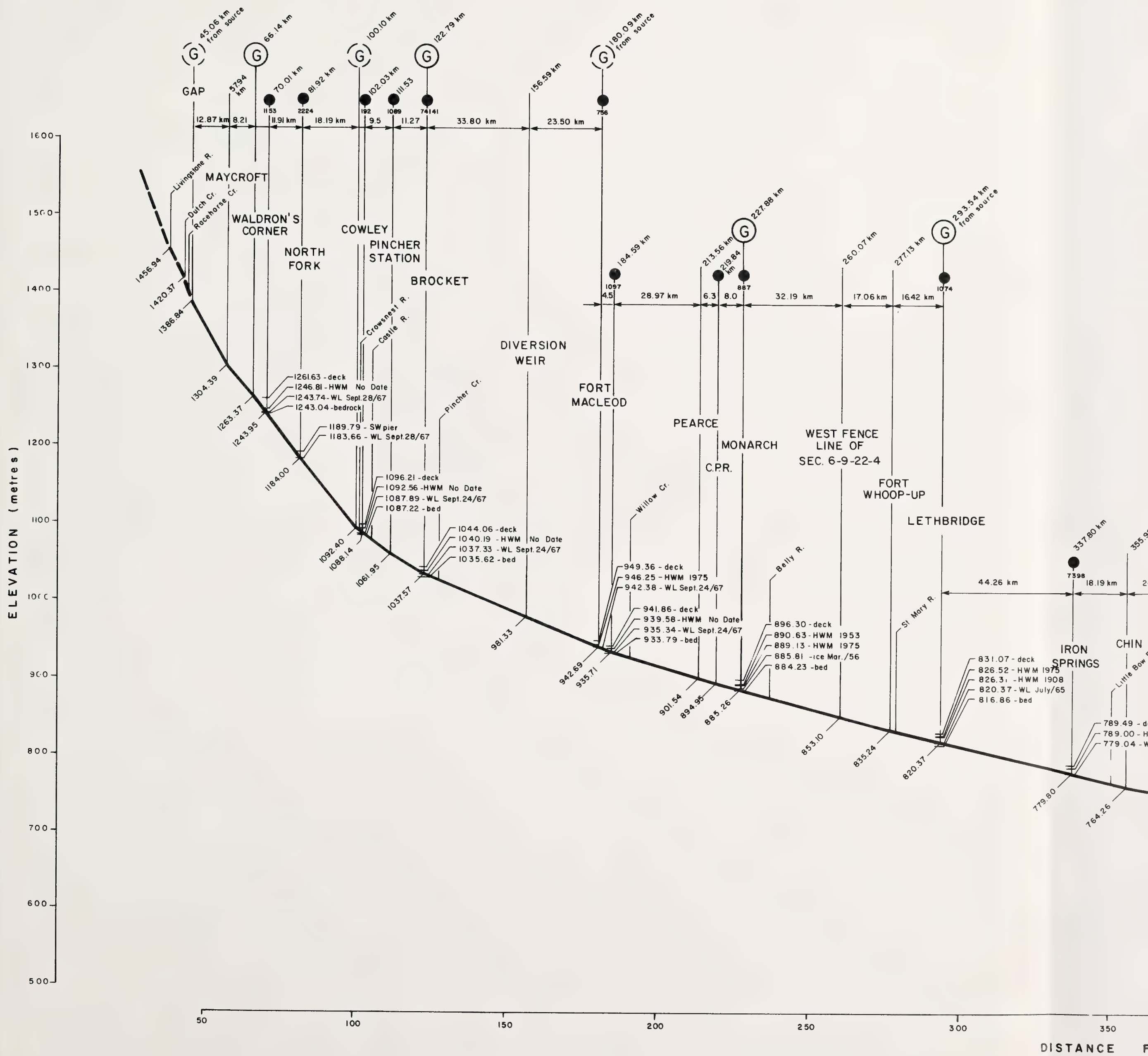

LONGITUDINAL PROFILE OF OLDMAN R

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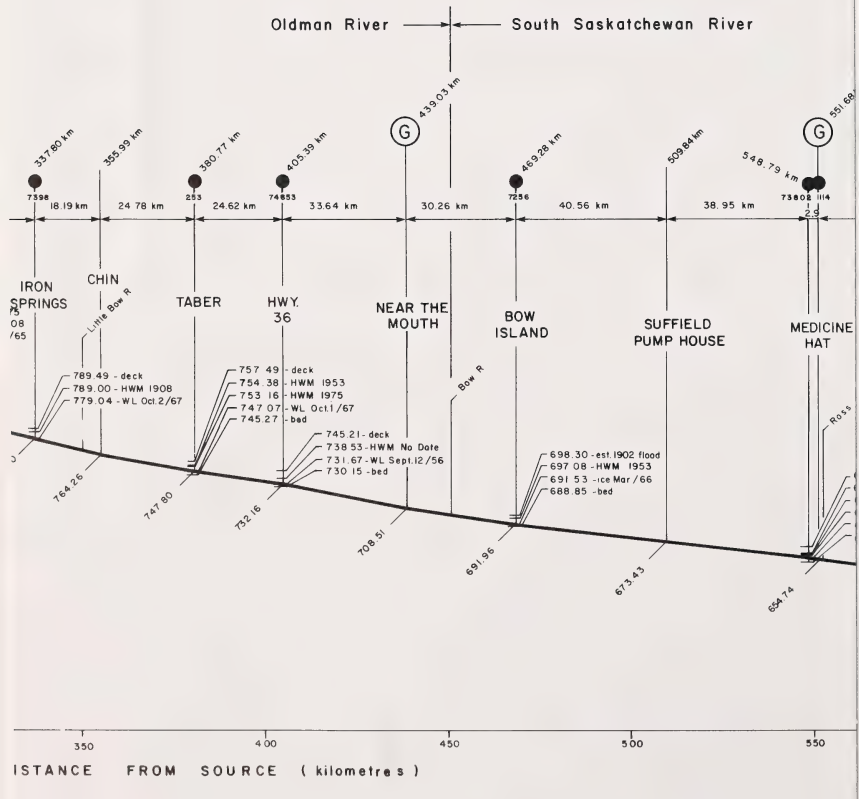
NOTES :

— Distances were measured along the river channel as indicated on 1 : 50 000 National Topographic maps and on 1 inch to 1 mile Planimetric maps.

— H. W. M. — High water mark as given on bridge drawing.

— Reference low stage corresponds to approximate long term mean flow.



MAN RIVER AND SOUTH SASKATCHEWAN RIVER

NOTES :

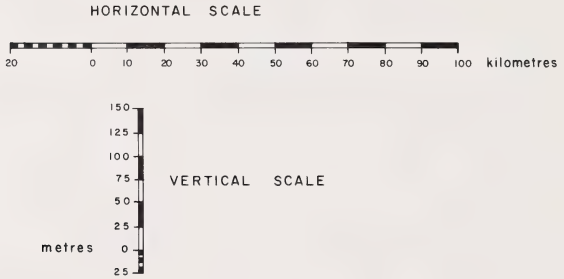
— Distances were measured along the river channel as indicated on 1 : 50 000 National Topographic maps and on 1 inch to 1 mile Planimetric maps.

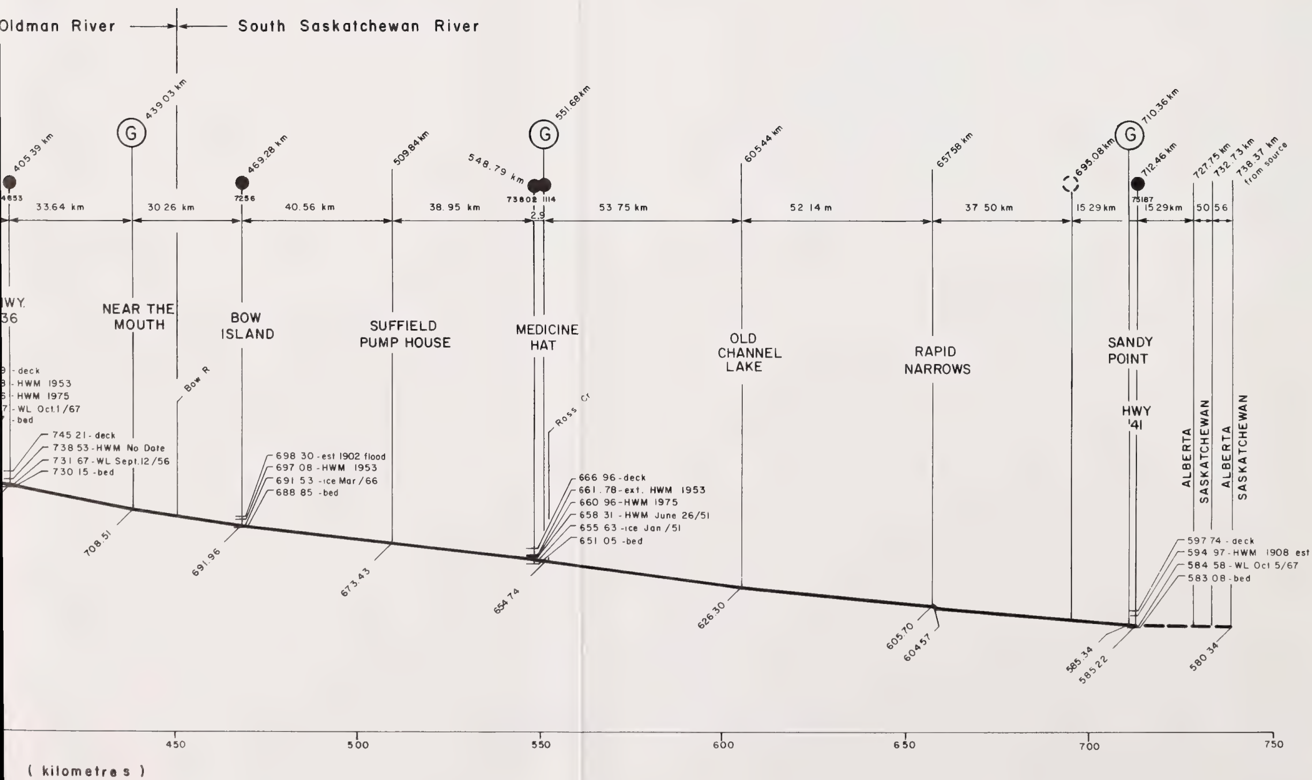
— H. W. M. — High water mark as given on bridge drawing.

— Reference low stage corresponds to approximate long term mean flow.

TABLE OF AVERAGE SLOPES

	DISTANCE (km)	FALL (m)	SLOPE (m / km)
SOURCE — GAP	45.06	701.04	15.56
GAP — WALDRON'S CORNER	21.08	123.47	5.86
WALDRON'S CORNER — COWLEY	34.01	170.96	5.03
COWLEY — BROCKET	22.60	54.83	2.43
BROCKET — FORT MACLEOD	57.37	94.88	1.65
FORT MACLEOD — MONARCH	47.85	57.42	1.20
MONARCH — LETHBRIDGE	65.56	64.89	0.99
LETHBRIDGE — IRON SPRINGS	44.26	40.57	0.92
IRON SPRINGS — TABER	42.97	32.00	0.75
TABER — HWY 36	24.62	15.64	0.64
HWY 36 — GAUGE near the MOUTH	33.64	23.65	0.70
GAUGE near the MOUTH — BOW ISLAND	30.26	16.55	0.55
BOW ISLAND — SUFFIELD PUMP HOUSE	40.65	18.53	0.46
SUFFIELD PUMP HOUSE — MEDICINE HAT	41.68	18.68	0.45
MEDICINE HAT — OLD CHANNEL LAKE	53.85	28.44	0.53
OLD CHANNEL LAKE — RAPID NARROWS	52.16	20.60	0.40
HEAD TO BASE OF RAPID NARROWS	0.40	1.13	2.80
RAPID NARROWS — HWY 41	52.32	19.23	0.37
HWY 41 — ALTA. - SASK. BOUNDARY	27.99	5.00	0.18





D SOUTH SASKATCHEWAN RIVER

FIG. 106